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Abstract

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JEL Classification: N/A

Keywords: ShortInterest;PublicDisclosure;InformationalEfficiency

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Keywords: Short Interest; Public Disclosure; Informational Efficiency

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1 Introduction

Arbitrageurs' activities are often viewed as essential for bringing prices in line with their fundamental value and creating efficient markets. In the aftermath of the recent financial market crisis, there has been increased attention on understanding the role of arbitrageurs and informed traders in financial markets. Specifically, there has been heightened interest and debate as to whether arbitrageurs and informed traders should face more stringent public disclosure requirements.[1] Regulatory policies aimed at higher public disclosure can help reducing opaque trading; however, these policies may also distort incentives to trade and subsequently impact informational efficiency. In this paper, we aim to contribute to this debate by analysing the impact of higher disclosure requirements in the shorting market.

We focus on the shorting market primarily for two reasons. First, there is ample evidence showing that short-sellers are an example of arbitrageurs and informed traders, adept at identifying mispriced securities and the direction of future price movements.[2] Second, there have been rule amendments in the U.S. securities market that have increased the public disclosure requirements of short positions. This policy change provides a useful experiment that allows us to identify the impacts of higher public disclosure requirements of arbitrageurs and informed traders.

The impact of increased public disclosure of short-sales could be potentially beneficial or harmful. Frictions involved in short-selling mean that information possessed by short-sellers diffuses slowly. Therefore, increased public disclosure of short-sales could improve informational efficiency by allowing the rest of the investing public to learn from short-sellers more promptly (Diamond and Verrecchia (1987)). In addition, increased public disclosure could also improve informational efficiency by increasing arbitrage activity. 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 are eroded due to accumulating transaction costs or the risk that the mispricing worsens in the short-run due to noise traders (Dow and Gorton (1994); Abreu and Brunnermeier, (2002); Barberis and Thaler (2003)).[3] If increased public disclosure of short positions hastens the diffusion

[1]See, for instance, the Title IV of the Dodd-Frank Act, which broadened the scope of regulatory disclosure requirements on investor advisors of private funds, including hedge funds.

[2]See, for example, Desai, et al. (2002); Jones and Lamont (2002); Asquith, Pathak, and Ritter (2005); Boehmer, Jones, and Zhang (2008); Karpoff and Lou (2010); Fang, Huang, and Karpoff (2015).

[3]Although the term "arbitrage", strictly speaking, refers to riskless speculation, we follow the related literature and use the term in a broader sense, that is, arbitrage refers to an investor's ability to detect mispriced securities (e.g., Easley, O'Hara, and Yang (2014); Kovbasyuk, and Pagano (2015)).

of short-sellers' information, then short-sellers' horizon risk would be reduced, thereby increasing short-selling activity and improving informational efficiency.

Increased public disclosure of short sales could be also potentially harmful to informational efficiency. It may reveal information about proprietary investment strategies that outside investors can free-ride off. This would prevent short-sellers from fully reaping the benefits of their private information, which may then hurt short-sellers' incentives to gather private information in the first place, worsening informational efficiency (Grossman and Stiglitz (1980)). There can be also other potential mechanisms through which informational efficiency may worsen with higher disclosure requirements. For instance, in Banerjee, Davis, and Gondhi (2014) and Goldstein and Yang (2017), public disclosure of fundamentals-related information can crowd out private information production; and in Han, Tang, and Yang (2014), disclosure attract noise trading. Although the mechanisms described in these studies are different, they all lead to a reduction in informational 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. We 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. U.S. securities exchanges publicly disclose each stock's total short interest, which is defined as the total outstanding short positions in a given stock, at the end of the settlement dates.

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 the short 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. Specifically, we test the difference 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 efficiency after the mid-month report dates between pre- and post-amendment periods. By taking the difference over and above the differences in informational efficiency after the mid-month report dates (which are available in both pre and post periods), we control for the possible market-wide 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.

Our results show that the new disclosure regime has an important impact on a stock's informational environment. We use a number of measures of informational efficiency and find that more frequent reporting of short interest hastens the diffusion of information and thus improves informational efficiency. The effects are pronounced for stocks with negative information, indicating new disclosure regime particularly helps with the diffusion of negative information, which tends to be revealed more slowly (Hong, Lim and Stein (2000); Cohen, Lou and Malloy (2014)).

In extended analyses, we run a number of tests to shed light on the mechanism driving our results. We start by examining market reactions to short interest announcements. If short interest contains valuable information that the investing public utilizes and learns from, we then expect to find significant market reactions to short interest announcements. Consistent with this, we document significant price adjustments on short interest announcement days. Price adjustments are much larger for stocks with increases in short interest, that is, stocks with more negative information.[4] Furthermore, we find that these price adjustments 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 use disclosures to send a false signal to the public to manipulate stock prices.

In addition, we examine how the mechanism driving the main results affects short-sellers' holdings periods, the returns short-sellers earn, and their related short-selling activity. If the effects we document are in fact driven by information possessed by short-sellers diffusing faster,

[4]Senchack and Starks (1993) have studied market reactions to short interest announcements from 1980 to 1986. We re-conduct this analysis for our sample period because market reactions to short interest announcements might be different in more recent periods due to increased transparency and the availability of more information in financial markets. In addition, we can overcome the data limitations faced by earlier studies - while Senchack and Starks (1993) were able to hand collect data on short interest only for a group of stocks, we can observe this for all Compustat companies.

we then expect there to be a decline in short-sellers' holding periods with the new disclosure regime. This is precisely what we find. In a similar vein, we find that short-sellers' strategies have a higher reward-risk ratio in the periods after the new disclosure regime, consistent with the idea that public disclosure of short interest helps diffusing negative information to the wider investing public, which assists short-sellers earn returns more reliably. Finally, we analyse the changes in short-selling activity. In line with the rest of the results, we find that short-sellers, as a group, take larger positions with the new public disclosure requirements.

Although the academic literature on short-selling is extensive, there is surprisingly little discussion of the impact of disclosure policies in the shorting market, despite its increasing relevance. In the aftermath of the recent financial crisis, short-sales regulations have focussed more on increasing disclosure, instead of imposing restrictions or bans on short-selling. One paper that also analyses the impact of short-selling disclosure policies is by Jones, Reed and Waller (2016). These authors focus 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 (2016) find that the E.U.'s disclosure regime negatively affects the amount of short-selling and informational efficiency. Jank, Roling, and Smajlbegovic (2016) suggest this might be because some short-sellers want to strategically avoid crossing the threshold for disclosing their short positions.

We 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 imposed public disclosure of each stock's total short interest, as opposed to releasing trader level information on large short-sales. Furthermore, 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. Our findings are different from Jones, Reed and Waller (2016) in that our analysis shows that higher disclosure requirements that only increase the reporting frequency of stock-level short interest can improve informational efficiency.

Another related paper from the shorting literature is by Ljungqvist and Qian (2016). The authors document that short-sellers sometimes voluntarily reveal their information to the public, which is contrary to the conventional wisdom that privately informed traders want to hide their information. Our paper complements Ljungqvist and Qian (2016) as we study mandatory public disclosures, which are frequent and regular, and must rely on actual positions. In addition, Ljungqvist and Qian (2016) focus on studying market reactions to voluntary disclosures. Different from this study, we also examine the efficiency implications of mandatory public disclosures and the effect the disclosures have on short-sellers' risks and trading activity.

More broadly, our paper is also linked to the literature that studies the effects of increased publicity of arbitrage activity and informed trading. The views in this literature are mixed. On the one hand, some authors argue that higher publicity is harmful as arbitrageurs may lose their informational advantages (e.g., Huddart, Hughes, and Levine (2001); Agarwal, Jiang, Tang, and Yang (2013); Agarwal, Mullally, Tang, and Yang (2015); Easley, O'Hara, and Yang (2013)). On the other hand, other authors emphasize the benefits that can come with publicizing private information (e.g., Kovbasyuk and Pagano (2015); Ljungqvist and Qian (2016); Makarov and Plantin (2012)). Studies in the latter group argue that, using public disclosures, arbitrageurs can overcome the limits of arbitrage arising from capital constraints and horizon risk. Our paper contributes to this debate by providing new evidence from the U.S. shorting market using the new rules implemented in the securities markets.

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

2 Methodology and Data Sources

2.1 Methodology

On March 6, 2007, the SEC approved amendments to revise the short interest reporting requirements of all major securities exchanges and the National Association of Securities 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.[5] Prior to the amendments, member firms were required to submit a mid-month short interest report which was based on short positions held on the settlement date, namely the 15th

[5]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 Inter-market Surveillance Group (ISG)" (May 2007), available at https://www.finra.org/sites/default/files/NoticeDocument/p019161.pdf

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 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. (ET) two business days after the settlement date to report their short positions. Short interest is then aggregated on a stock-by-stock basis across all member firms and publicly disseminated after 4:00 p.m. (ET), eight business days later, on pre-scheduled announcement days.[6] 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, as 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 identifying the impact of short interest disclosure, because 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 when short interest would have been publicly reported had broker-dealers been required to report 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 $REPDATEs$, 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 $REPDATEs$, they do receive this information on the actual $REPDATEs$.

To estimate the effect the additional short interest disclosure has on informational efficiency,

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

we estimate the following regression model:

$$EFF_{i,t} = \alpha_i + \beta_0 e_{i,t} + \beta_1 POST_{i,t} + \beta_2 [e \times POST]_{i,t} + \gamma X_{i,t} + \varepsilon_{i,t} \tag{1}$$

EFF denotes our measures of informational efficiency for stock i at time t . For the independent variables, we include e, which is a dummy variable that equals 1 for observations after the end-of-month $REPDATE$ and before the mid-month $REPDATE$ the following month, and equals 0 for observations after the mid-month $REPDATE$ and before the end-of-month $REPDATE$. The variable, $POST$, is a dummy variable that equals 1 for observations in the post-amendment period, that is, after September 7, 2007, and zero otherwise; and the variable $[e \times POST]$ is an interaction term between $POST$ and e.

The coefficient on the interaction variable, β_2, is the key variable of interest in our analysis as it quantifies the impact of the extra short interest announcement that investors receive in the post-amendment period. Our methodology is a differences-in-differences test in which we test the differences in informational efficiency after the end-of-month $REPDATE$ between pre- and post-amendment periods, over and above the differences in informational efficiency measured 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 informational efficiency measured after the mid-month short interest announcements, we control for the possible aggregate changes in efficiency from the pre- to post-amendment period. 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.

Our main measure of informational efficiency is the cumulative abnormal returns around quarterly firm earnings announcements. Specifically, we calculate $CAR[m,n]$, which is the absolute value of cumulative abnormal returns measured in either [0,1] or [2,61] days after the firm's earnings announcement that occur after the actual or placebo $REPDATE$. This measure has been also used by previous studies such as Kim and Verrecchia (1991), Kelly and Ljungqvist (2012), Boehmer and Wu (2013), and among others. There are a number of advantages of using this measure in our empirical setting. This measure of informational efficiency nicely ties in with related papers which show that short interest is informative about upcoming earnings announcements [e.g. Christophe, Ferri and Angel (2004); Francis, Venkatachalam and Zhang (2005); Christophe, Ferri and Hsieh (2010); Boehmer, Jones and Zhang (2015)]. Therefore, short interest announcements are expected to provide an informed signal to investors from which they can learn about a firm's news more readily, therefore investors may not be as surprised by the earnings news when they arrive. Second, earnings announcements allow us to analyze the asymmetric effects of positive versus negative information – a feature that cannot be easily captured by other measures of informational efficiency. Therefore, we use abnormal returns due to quarterly firm earnings announcements as the main measure, but later in Section 3.2.5, we broaden the analysis to alternative measures of informational efficiency.

In robustness tests, we include a vector of control variables, X_{it}, which the previous literature shows to be related to our measures of informational efficiency. In addition, we include year, month and day-of-week time fixed effects as well as industry and stock fixed effects.[7] Standard errors are double-clustered by stock and earnings announcement day.

2.2 Data Sources and Variables

The sample consists of common stocks (with share codes of 10 or 11) from the CRSP-Compustat universe. Market data is obtained from the CRSP Daily Files, and financial-statement related information is obtained from the Compustat Merged Security Monthly File. Analyses that are based on earnings announcements use additional data from I/B/E/S. When the earnings announcement date is included in both Compustat and I/B/E/S 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.[8] Earnings announcements released after 4:00 p.m. (ET) 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 literature commonly follows Bernard and Thomas (1989), who report that most of the post-earnings announcement drift occurs during the first 60 days. We obtain similar results when we use 75 days

[7] 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.

[8] DellaVigna and Pollet (2009) report that the earlier of the two dates is almost always the correct announcement date in the post-1994 period.

as the post-announcement window.

We measure market reactions to earnings announcements by the absolute value of cumulative abnormal returns to earnings 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 (B/M) matched portfolio,[9] 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. We use the absolute value of cumulative abnormal returns since we are interested in comparing the size of earnings reactions after short interest announcements. Later in Section 3.2.4, we analyze whether the size of the earnings reactions depends on the earnings announcement being a negative or a positive surprise.

As the objective of our paper is to analyze the impact of the new regulatory regime, we divide the sample into two sub-periods around the rule 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

[9] 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

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.

Shortly after the SEC approved amendments, stock markets experienced dramatic turbulence and the SEC implemented temporary prohibitions and bans to short selling. Although 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 which 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)]. We control for the number of analysts following the stock ($NUMEST$); earnings persistence ($EARNINGS\_PERSIST$); earnings volatility ($EARNINGS\_VOL$); forecast error (FE), the number of earnings announcements on the given day of a firm's own earnings announcement ($NUMANN$); and institutional ownership (IO). Definitions of these variables can be found in Appendix A.

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 stock turnover ($TURNOVER$); stock price volatility ($VOLATILITY$); and bid-ask spread ($SPREAD$). Different from $TURNOVER$ and $VOLATILITY$, we measure $SPREAD$ prior to the earnings announcements since trading by informed investors, and thus asymmetric information, intensifies before earnings announcements. Definitions of these variables can also be found in Appendix A.

3 Results

3.1 Descriptive Statistics

In Table 1, we present descriptive statistics for our main analysis. Panel A presents the descriptive statistics for the sample of firms where $e = 0$, and Panel B presents the descriptive statistics for the sample of firms where $e = 1$. As 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.

The main result from Table 1 is that there are no meaningful differences 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 empirical specifications. Overall, findings in Table 1 support our empirical design.

3.2 Main Results

3.2.1 Short-Term Price Reactions to Earnings Announcements

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-amendment period, the market reaction to earnings announcements that occur after the end-of-month $REPDATE$ is 30 bps lower than after the 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 important observation to note is that in the pre-amendment 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 $REPDATE$. 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 afterwards. These estimates also imply that differences in market reactions between earnings announcements that take place after the mid-month $REPDATE$ and the end-of-month $REPDATE$ the following month dissipate in the post-amendment period.[10] 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 and time fixed effects. Consistent with the 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 conclusions. 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 announcement at different times within the month. In column 3 of both panels, we control for $NUMANN$, 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

[10] 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.

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 $[e \times POST]$ 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 Other Short-Term Effects Around Earnings Announcements

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 asymmetric information. To that effect, we estimate the regression model in (1); however instead, we use $TURNOVER$, $VOLATILITY$ and $SPREAD$ as the dependent variables.

In Table 3, we start by using $TURNOVER$ as the dependent variable. We include the control variables discussed above, and time, industry and stock fixed effects. The coefficient on $[e \times POST]$ is negative (-0.0011) and statistically significant, implying 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, in Column 2, we use $VOLATILITY$ as the dependent variable and find that the coefficient on $[e \times POST]$ 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, earnings announcements occurring 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 also expect the regulatory amendments to impact information asymmetry and liquidity.

Revelation of short-sellers' private information through increased public disclosure of short interest may reduce asymmetric information, and therefore lower the bid-ask spread. We measure bid-ask spreads prior to the earnings announcements because informed trading is expected to rise before earnings announcements [e.g. Copeland and Galai (1983); Glosten and Milgrom (1985)]. The results show that the coefficient on $[e \times POST]$ 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 findings in Table 2.

3.2.3 Long-Term Price Reactions to Earnings Announcements

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)]. 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 (1) 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 $[e \times POST]$ 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 $[e \times POST]$ are negative and statistically 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 results from Table 2 suggesting that there is less post-earnings announcement drift, and therefore greater informational efficiency after the regulatory amendments.

3.2.4 Asymmetric Effects: Negative Earnings Announcements

In this section, we analyze whether there are asymmetric effects depending on whether the earnings announcement was a negative or a positive surprise. If more frequent disclosure of short interest help investors promptly learn about short-sellers' private information (which contain negative information), we would expect that investors would be less surprised particularly by negative earnings announcements released after these short interest announcements.

To test this idea, we pursue a triple-differences approach and define, $NEGNEW$, which is a dummy variable that equals 1 if the firm's earnings surprise is negative. The main variable of interest in this section is the coefficient on $[e \times POST \times NEGNEW]$ which shows the differential impact of the extra short interest announcement on negative earnings announcements in the post-amendment period. Table 5 shows the the results from Table 2-4, including $NEGNEW$ and all of its related interaction terms with e and $POST$.

We use measures of both short-term and long-term reactions to earnings announcements and find that the coefficient on $[e \times POST \times NEGNEW]$ is negative and significant across all specifications. Results are also economically significant. For instance, we observe an additional 22 bps and 123 bps reduction, respectively, on short-term and long-term price reactions to negative earnings announcements, indicating that the effects of rule amendments on negative earnings surprises is more than the double of the effect it has on the rest of the sample stocks. These results show that greater disclosure of short interest particularly helps with the diffusion of negative information which tends to travel slowly (Hong, Lim and Stein, 2000; Cohen, Lou and Malloy, 2014).

3.2.5 Alternative Measures of Informational Efficiency

In this section, we test whether our main results from Table 2-4 hold when we use alternative measures of informational efficiency which do not depend on earnings announcements. Our first approach is to follow Hou and Moskowitz (2005) and estimate price delay—a measure of the delay in which stock prices respond to market information. The greater price delay is, the more the stock's return variation can be captured by lagged market returns, indicating less informational efficiency.

We adopt a variant of Hou and Moskowitz's (2005) measures because they are estimated only once per year using the time series of one year of lagged returns. We estimate Hou and Moskowitz's (2005) measures of price delay using the cross-section of all stocks between two consecutive $REPDATEs$ (including placebo report dates). Therefore, there is a single price delay corresponding to each $REPDATE$. Our first price delay measure is $DELAY1$, which considers the impact of lagged market returns predicting future stock returns. The second measure, $DELAY1\_NEG$, is similar to the first one, but it differs from it by using only negative lagged market returns for the estimation. The third measure, $DELAY3$, distinguishes between shorter and longer lags of market returns and accounts for the precision of estimates on the coefficient of lagged market returns. Further details regarding the calculation of these variables can be found in Appendix A.

We estimate our main regression equation using $DELAY1$, $DELAY1\_NEG$, and $DELAY3$ as our measures of information efficiency. Because our delay measures are estimated using the cross-section of all stocks between $REPDATEs$ – as opposed to being estimated for each stock individually – stock specific control variables are no longer included in these regressions. Table 6 shows that results are consistent with previous findings. Coefficients on $[e \times POST]$ are significantly negative regardless of the delay measure used, which indicates improvements in informational efficiency.

Furthermore, we calculate high frequency measures of informational efficiency based on intraday trades and quotes from TAQ. Our first high frequency measure of informational efficiency is based on studies such as Boehmer and Kelley (2009) which use variance ratios to test whether prices follow a random walk. A random walk implies that the ratio of longer-term to shorter-term return variances, scaled by unit of time should be equal to one. As we are interested in deviations of actual transaction prices from their efficient prices (random walk) irrespective of sign, we construct our measure of variance ratio, defined as $VARRATIO = \left|1 - \frac{var(30min)}{30var(1min)}\right|$, where $var(30min)$ is the variance of overlapping 30-minute intraday returns and $var(1min)$ is the variance of overlapping 1-minute intraday returns.[11] According to this measure, smaller $VARRATIO$ indicates that stock prices are more informationally efficient. Table 7 report results using $VARRATIO$ as the measure of informational efficiency. Column 1 shows results with no control variables; Column 2 includes control variables that might be associated with high frequency measures of informational efficiency. We find that the coefficient on $[e \times POST]$ in both specifications are significantly negative.

Our second high frequency measure of informational efficiency is based on calculating pricing

[11] For further details regarding processing of TAQ data and constructing of the variance ratio, please refer to Appendix B.

errors (e.g. Hasbrouck (1993); Boehmer and Kelley (2009); Boehmer and Wu (2013)). We decompose log intraday transaction prices from TAQ into an efficient price, random walk component (m_t) and a stationary component, the pricing error (s_t).[12] We then construct the scaled pricing error, $PE = \frac{\sigma(s)}{\sigma(p)}$, where $\sigma(s)$ is the standard deviation of the pricing error, which is assumed to follow a zero-mean, covariance-stationary process, and $\sigma(p)$ is the standard deviation of intraday transaction prices, used to control for cross-sectional differences in price volatility. According to this measure, small PE indicates that stock prices are more informationally efficient. Columns 3 and 4 of Table 7 show results using PE as the measures of informational efficiency. Consistent with previous findings, we find that the coefficients on $[e \times POST]$ are significantly negative.

3.3 Robustness Analyses

3.3.1 Alternative Sample Periods

As discussed in Section 2, our sample period runs from January 2003 to December 2012, excluding 2008. In Panel A of Table IA.1 (reported in the Internet Appendix), we re-estimate our results from Tables 2-4 using an equal 48-month window in the pre- and post-amendment period, excluding all observations from 2008. This ensures that the pre- and post-amendment periods are of equal distance from the date of the regulatory amendments. In Panel B, we re-estimate our results using 48 months in the pre-amendment period and 60 months in the post amendment period, excluding all observations from 2008. This ensures that there are an equal number of $REPDATEs$ in the pre- and post-amendment periods. These two empirical choices are complementary and we analyze whether our results are sensitive to using alternative sample periods. We find that in both panels, the coefficient on $[e \times POST]$ across all specifications is negative, statistically significant and of comparable magnitude to results presented in Tables 2-4. This robustness check provides support that the choice of sample period does not drive our results.

3.3.2 Timing of Earnings Announcements

The underlying idea behind our empirical methodology is that firms that release their earnings announcements after the mid-month $REPDATE$ are not meaningfully different from firms that release their earnings announcements after the end-of-month $REPDATE$. In support of this, in

[12]For further details regarding processing of TAQ data and constructing the pricing error, please refer to Appendix B.

Table 1, we showed that the timing of earnings announcements relative to the $REPDATE$ is not associated with significant differences in terms of firm characteristics. In Tables 2-5, we controlled for these firms characteristics in our regressions, and in further tests, we also included stock fixed effects to control for unobservable firm characteristics. Our results remained robust after including these controls.

To further assess whether the timing of a firm's earnings announcements affects our results, we re-estimate Tables 2-4 using a sub-sample of firms which have propensity to release their earnings announcements in the same time-frame relative to the end-of month $REPDATE$, in both the pre- and post-amendment periods. We determine propensity by calculating the average value of $e(\bar{e})$ for each firm in the pre- and post-amendment period. If $\bar{e} > 0.5$ ($\bar{e} < 0.5$) for a given firm in both the pre- and post- amendment period, we classify the firm as having a tendency to release earnings in the same timeframe relative to the end-of month $REPDATE$, in both the pre- and post-amendment periods. The sub-sample constructed in this way contains about 65% of firms included in the original sample. Results are reported in Table IA.2 of the Internet Appendix. We observe that the coefficient on $[e \times POST]$ across all specifications is negative, statistically significant and of comparable magnitude to the results presented in Tables 2-4. This robustness check highlights that the timing of earnings announcements does not drive our results.

3.3.3 Alternative Data Sources for Acquiring Information on Short Selling

There might be alternative ways through which investors can access some information on short-selling. For instance, Markit is a private data vendor that provides data on securities lending market. Investors who are subscribed to Markit receive regular updates on total short positions taken by Markit's subscribers. The availability of Markit data may at first appear as a concern for the empirical design, however, for a number of reasons, we believe that the availability of Markit data is actually not central to the interpretation of our findings. First, Markit reports only the total short positions taken by its subscribers, not the whole market.[13] Second, Markit data has been available (either at the daily or weekly frequency) throughout our sample period including the pre-amendment period. Therefore, it is unlikely to explain our results; if anything, it is likely to go against finding significant differences between the pre- and post-amendment periods. Third, due to its high subscription fees, Markit data is unlikely to be available to a large number of

[13]For a typical stock, the sum of the short positions taken by Markit's subscribers constitute about half of all short positions taken. Subscribers include prime brokers, custodians, asset managers and hedge funds.

investors.

Therefore, we believe that the availability of Markit data is unlikely to be a major concern; nevertheless, we conduct robustness tests to assess the role of Markit data. To this end, we exploit the dates when Markit changed its reporting frequency of its short-sales data. Markit has provided data on total short positions since June 2002. Markit initially released monthly data on total short positions on its covered universe between June 2002 and July 2004. It then released weekly data between August 2004 and June 2006, and finally released daily data from July 2006 through to present. Note that all of these changes occured in the pre-amendment period.

We analyze whether this more frequent disclosure of Markit data had any effect on the informational efficiency. Specifically, we conduct before-and-after analyses using the three experiements took place on: (i) June 2002, where Markit first started providing monthly data, (ii) August 2004, when reporting frequency of Markit data increased from monthly to weekly, and (iii) July 2006, when the reporting frequency increased from weekly to daily. We introduce dummy variables ($MONTHLY$, $WEEKLY$, and $DAILY$) to capture the effects before and after each change. Results are reported in Table IA.3 of the Internet Appendix. With the exception of the first experiment (for which there is some, albeit weak, evidence suggesting increases in informational efficiency), we find that change in the reporting frequency of Markit data does not have any impact on informational efficiency. This is perhaps not particularly surprising for the reasons discussed above.

In addition to Markit data, commencing from the fourth quarter of 2009, FINRA started publishing aggregate short volume data by security on each day. As opposed to short interest, which is calculated as the total outstanding open positions at the end of each day, short volume is the amount of short-sale trades executed within a trading 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. If the availability of this alternative data source (or alike) makes the disclosure of short interest by securities exchanges obsolete, then we would not observe significant market reactions to changes in short interest on short interest announcement days. We analyze this in the next section.

3.4 Mechanism Analyses

3.4.1 Market Reactions to Short Interest Announcements

We have shown that increasing the frequency of short interest disclosure improves informational efficiency. This is consistent with the hypothesis that investors learn about short sellers' private information more promptly with greater disclosure. In this section, we examine the market reactions to short interest announcements to provide further evidence of this channel. Diamond and Verrecchia (1987) show that, due to costly short-selling and short-selling constraints, short-sellers' information diffuses slowly. Therefore, we expect that changes in short interest that is not yet public may contain new information that can help the investing public improve their inferences, and this can lead to a price adjustment on short interest announcement days.

To examine this, we calculate the price reactions to $\Delta SHORT$, 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. 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, we form 10 portfolios based on changes in short interest on each announcement date.[14] For consistency, our sample period is from January 2003 to December 2012 (excluding 2008); however, the universe of stocks in this analysis is the merged CRSP-Compustat universe. As short-selling conveys pessimistic information, we expect a negative relationship between changes in short interest and stock returns.

Previously, Senchack and Starks (1993) have studied market reactions to short interest announcements from 1980 to 1986. We re-conduct this analysis during our sample period because market reactions to short interest announcements might be different in more recent periods, for instance, due to the availability of more information on short-selling activity. Furthermore, we can overcome the data limitations experienced by Senchack and Starks (1993) – while Senchack and Starks (1993) were able to hand collect data on short interest only for a group of stocks, we can observe this for all firms on listed exchanges.

Panel A of Table 8 reports the average 2-day announcement returns adjusted for size and book-to-market ratio, and alphas estimated from a 3-factor and a 4-factor model by for portfolios formed on $\Delta SHORT$. Using all three measures, we find a significant negative relationship between

[14] Compustat consolidates data from the exhanges' websites on short interest from the public announcements, therefore it is precisely the information disseminated to public.

changes in short interest and announcement returns. 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 15 bps (approximately a monthly alpha of 300 bps) and is significant at the 1% level. 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. [15]

To visualize these results, Figure 2 shows the cumulative 4-factor alphas for the top and bottom decile portfolios starting from 7 trading days prior to the short-interest announcements until 10 trading days after the short-interest announcements. Consistent with the portfolio results in Panel A of Table 8, we find a prominent decline in prices for the top decile portfolio and a slight increase in prices for the bottom decile portfolio. An additional useful 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 announcements. We also confirm this in portfolio tests reported in Panel B of Table 8.

We conduct a subsample analysis to see whether market reactions to short interest announcement have been different in the pre- and post-amendment periods. If there is more information available on short-selling activity in the post-amendment period, short interest may no longer be much informative, as such the announcements would not trigger a significant price adjustment in the post-amendment period. We find that this is not the case. Panel C of Table 8 reports the average 2-day short interest announcement returns before and after the rule amendments. Market reactions to short interest announcements are, if anything, significantly larger in the post-amendment period. This result reinforces our findings from the previous section that alternative data sources on short-sales do not undermine our conclusions.

In addition, we examine cross-sectional variation in the market reactions to short interest announcements. In Figure 3, we plot the cumulative 4-factor alphas for the decile portfolios for stocks in the smallest and largest quintile of market capitalization, and stocks in the lowest and highest quintile of book-to-market. We find that market reactions to short interest announcements are larger for small stocks – which tend to have poorer informational environments compared to large stocks [e.g. Hong, Lim and Stein (2000); Zhang (2006)] – and for stocks with low book-to-market ratios, which are often targeted by short-sellers [Dechow, et al. (2001); Hanson and

[15] These results are both qualitative and quantitatively similar to the results from related studies. For instance, Kelley and Tetlock (2016) reports that a high-minus-low portfolio constructed on quintiles of lagged retail daily short-selling activity lead to a daily alpha of 7 bps over the next day. A larger fraction of alphas are driven by stocks with high short-selling activity.

Sunderam (2014)].

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 use public announcements 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 a possible reversal effect, in Figure 4, we show the cumulative 4-alphas over the next 60 trading days after the $REPDATE$ for the top decile portfolio. The plot shows the long-term patterns not only for the full sample, but also for the subsamples of stocks which might be more susceptible to market manipulation (e.g., small stocks). We don't find any reversals in any of our samples, indicating that the price reactions due to short interest announcements are long-lasting.

3.4.2 Short-Sellers' Holding Periods, Reward-to-Risk Ratios and Short Selling Activity

Short-sellers face important horizon risks—the risk that a mispricing can take too long to correct so that potential profits of arbitrageurs are eroded by accumulating transaction costs or the risk that the mispricing worsens in the short-run due to noise trading activity [Dow and Gorton (1994); Abreu and Brunnermeier (2002); Barberis and Thaler (2003)]. 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' subsequent positions. Furthermore, faster diffusion of information may reduce the risk of experiencing adverse price movements, which help short-sellers earn abnormal returns more reliably and lead to an increase in higher short-selling activity in the post-amendment period. In this section, we examine these hypotheses.

We start by measuring the holding horizon of short-sellers' positions using data from Markit. Markit reports the weighted average number of (calendar) days that transactions have been open. We use data from July 3, 2006 onwards—the date in which Markit commenced reporting data at a daily frequency. We take the average of all loans for a stock between two consecutive short interest announcement days and run the following regression:

$$LOANLENGTH_{i,t+1} = \alpha_i + \theta_0 e_{i,t} + \theta_1 POST_{i,t} + \theta_2 [e \times POST]_{i,t} + \lambda X_{i,t} + \varepsilon_{i,t} \quad (4)$$

where $LOANLENGTH_{i,t+1}$ is the average loan tenure for a stock after a short interest announcement and prior to the next short interest announcement (including both actual and placebo announcements). We include control variables for stock characteristics that might be related to short-sellers' holding period such as stock's market capitalization, book-to-market ratio, idiosyncratic volatility, past cumulative monthly returns and illiquidity. We also include year, month, day-of-week time fixed effects as well as stock fixed effects. If the regulatory amendments hasten the speed in which information is impounded into prices, then the holding horizon of short sellers' positions would be reduced. If this is the case, we should then observe $\theta_2 < 0$. In Table 9, we show that in both specifications, the coefficient on $[e \times POST]$ is indeed negative and statistically significant. The estimates correspond to an approximate 9-12% decrease in short sellers' holding periods.

We next analyze the impact of the regulatory amendments on the reward-to-risk ratios of short-sellers' positions. If short-sellers' information is impounded into prices more readily with the regulatory amendments, then short-sellers should be able to earn higher returns with greater certainty. We test this prediction using the Markit database because it allows us to observe short positions on both actual and placebo report dates, while short interest from Compustat is what is disclosed to the public, thus it only allows us to observe short interest only on actual report dates.

On each $REPDATE$ (including both actual and placebo report dates), we form 10 portfolios based on changes in short interest from the previous $REPDATE$. $\Delta SHORT\_MARKIT$ is the change in short interest based on Markit data between two consecutive $REPDATEs$, scaled by stock's shares outstanding at the end of the month. After forming the portfolios, we use the daily returns until the next $REPDATE$ and calculate the 4-factor alphas and its standard deviations for each portfolio. Table 10 reports the reward-to-risk ratios, where reward-to-risk ratio is defined as the 4-factor alpha divided by its standard deviation. Results indicate that, with the new reporting regime, short-sellers earn higher abnormal returns with greater statistical significance. For instance, consider a strategy that is long on stocks with $\Delta SHORT\_MARKIT$ below the 10th percentile and short on stocks with $\Delta SHORT\_MARKIT$ above the 90th percentile. Portfolios formed after the end-of-month $REPDATE$ in the post-amendment period ($POST = 1$ and $e = 1$) have a reward-to-risk ratio of 2.5, while portfolios formed after the placebo end-of-month$REPDATE$ in the pre-amendment period ($POST = 0$ and $e = 1$) have a reward-to-risk ratio of 1.54. In line with our previous results, this difference is mostly driven by stocks that are heavily shorted.

Finally, in addition to examining short-sellers' holdings periods and reward-to-risk ratios, we ask whether the amount of short-selling activity is also affected after the rule amendments. We expect that after the regulatory amendments, due to negative information diffusing faster and thus smaller horizon risk, short-sellers might be more willing to take positions. To examine this, we run the following regression:

$$\Delta SHORT\_MARKIT_{i,t+1} = \alpha_i + \kappa_0 e_{i,t} + \kappa_1 POST_{i,t} + \kappa_2 [e \times POST]_{i,t} + \Upsilon X_{i,t} + \varepsilon_{i,t} \tag{5}$$

$\Delta SHORT\_MARKIT$ is the change in short interest based on Markit data, scaled by stock's shares outstanding at the end of the month. It is calculated after $REPDATE$ and before the next $REPDATE$. Regressions include control variables for stock characteristics that might be related to changes in short interest, such as stock's market capitalization, book-to-market ratio, idiosyncratic volatility, past cumulative monthly returns and illiquidity. If short-sellers are more active after the regulatory amendments, this would result in larger short positions, that is, $\kappa_2 > 0$. Table 11 show results that are consistent with this hypothesis. We find that the coefficient on $[e \times POST]$ is positive and significant across all specifications, indicating that there is an increase in the amount of short-sales activity after the regulatory amendments.

Overall, these results provide evidence corroborating the findings we previously presented. Although the analysis in this section uses data that covers only a part of short-sales (the part covered by Markit), the results are useful in suggesting that extra short interest disclosure at the end of each month in the post-amendment period have important implications. The regulatory amendments seem to reduce short-sellers' holding periods, assist short-sellers earn higher rewards per risk and increase short-selling activity.

4 Conclusion

In this paper, we investigate the role that greater disclosure of arbitrage activity and informed trading has on informational efficiency. To anwer this question, we study the shorting market and exploit SEC approved amendments to exchange rules, which increased the reporting requirements of short interest from once-a-month to twice-a-month as of September 2007. Greater public disclosure can potentially improve or deteriorate informational efficiency. Therefore the effect of disclosure policies in the shorting market on informational efficiency is an empirical question.

We estimate the changes to informational efficiency with more frequent reporting of short interest using a differences-in-differences test. Our identification strategy relies on placebo dates, that is, dates when short interest would have been publicly reported had broker-dealers been required to report short interest positions at the end-of-month in the pre-amendment period. 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. Higher public disclosure reduces market's errors in expectations and the time horizon in which information is incorporated into prices. Furthermore, consistent with our main findings, we document significant market reactions to short-sales announcements, suggesting that wider public learn from short interest announcements. Finally, the analyses show that greater short interest disclosure reduces short-sellers' subsequent holding periods, helps them earn higher abnormal returns more reliably, and leads to higher short-selling activity.

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Appendix A. Definition and Description of Variables

Variable Name	Name	Description	Source
REPDATE	Disclosure date of Short Interest Announcement	Date of mid-month and end-of-month short interest announcements. This also includes the placebo *REPDATEs* in the pre-amendment period.	Compustat
POST	Post-Amendment Period	Dummy variable that equals 1 for observations in the post-amendment period, that is, after September 7, 2007, and zero otherwise.	Compustat
e	Observations relative to Short Interest announcement date	Dummy variable that equals 1 for observations after the end-of-month *REPDATE* and before the mid-month *REPDATE* the following month.	Compustat
CAR[0,1]	Cumulative abnormal returns over announcement period	Calculated two ways: (1) Absolute value of difference between buy-and-hold returns of the stock over [0,1] and *beta* multiplied by the buy-and-hold return of the market over [0,1]; (2) Absolute value of difference between buy-and-hold returns of the stock over [0,1] and that of a size and book-to-market matched portfolio over [0,1]. *beta* used in (1) is estimated from regressing daily stock returns on daily market returns using [*t*-300,*t*-46] window where *t* is the date of the earnings announcement.	CRSP, Fama-French
CAR[2,61]	Cumulative abnormal returns over post-announcement period	Calculated two ways: (1) Absolute value of difference between buy-and-hold returns of the stock over [2,61] and *beta* multiplied by the buy-and-hold return of the market over [2,61]; (2) Absolute value of difference between buy-and-hold returns of the stock over [2,61] and that of a size and book-to-market matched portfolio over [2,61]. *beta* used in (1) is estimated from regressing daily stock returns on daily market returns using [*t*-300,*t*-46] window where *t* is the date of the earnings announcement.	CRSP, Fama-French
NUMEST	Number of Analysts	Natural logarithm of one plus the number of analysts giving EPS forecasts for the given firm in that quarter.	I/B/E/S
EARNINGS_PERSIST	Earnings Persistence	First-order autocorrelation coefficient of quarterly EPS during the past 4 years.	I/B/E/S, Compustat
EARNINGS_VOL	Earnings Volatility	Standard deviation of quarterly EPS in the past four years.	I/B/E/S, Compustat

FE	Forecast Error	Absolute value of difference between the announced earnings and the consensus EPS forecast normalized by the firm's stock price at the end of the corresponding quarter. The consensus EPS forecast is calculated as in Hirshleifer, Lim and Teoh (2009).	I/B/E/S, Compustat, CRSP
IO	Institutional Ownership	Fraction of all shares outstanding held by institutional investors for a given stock at the end of the quarter (in %).	Thomson Reuters
TURNOVER	Stock Turnover	Average daily trading volume in the [0,1] days around the earnings announcement divided by shares outstanding at the end of the month.	CRSP
VOLATILITY	Stock Price Volatility	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.	CRSP
SPREAD	Bid-Ask Spread	Daily (%) average bid-ask spread over the [-4,-2] window before the earnings announcement.	CRSP
NEGNEW	Negative Earnings Announcement	Dummy variable that equals 1 if the firm's earnings surprise is negative.	Compustat, I/B/E/S
*DELAY*1	Price Delay (1st Measure)	Using data between *REPDATEs*, we first run the following regression across all stocks: $$r_{j,t} = \alpha + \beta R_{m,t} + \sum_{n=1}^{4} \delta^{(-n)} R_{m,t-n} + \varepsilon_{j,t}$$ where $r_{j,t}$ is the stock's return in week *t* and $R_{m,t}$ is the return on the CRSP value-weighted market index in week *t*. We then calculate *DELAY*1 between *REPDATEs* as follows: $$DELAY1 = 1 - \frac{R^2_{\delta^{(-n)}=0,\forall n\in[1,4]}}{R^2}$$ where $R^2_{\delta^{(-n)}=0,\forall n\in[1,4]}$ is the R^2 from the regression above where all the coefficients on $\delta^{(-n)}$ are restricted to zero, is divided by the R^2 from the regression above with no restrictions.	CRSP
*DELAY*1_*NEG*	Price Delay (2nd Measure)	*DELAY*1_*NEG* is calculated using the same method as *DELAY*1, except we only use negative market returns in the estimation (positive market returns are set to equal zero).	CRSP

*DELAY*3	Price Delay (3rd Measure)	Coefficient estimates are first calculated using the regression from *DELAY*1. Next, we calculate *DELAY*3 between *REPDATEs* as follows: $$DELAY3 = \frac{\sum_{n=1}^{4} n\delta^{(-n)} / se\left(\delta^{(-n)}\right)}{\beta / se(\beta) + \sum_{n=1}^{4} \delta^{(-n)} / se\left(\delta^{(-n)}\right)}$$ where se(.) is the standard error of the coefficient estimate.	CRSP
VARRATIO	Variance Ratio	Calculated for each stock on each trading day as follows: $$VARRATIO = \left\lvert 1 - \frac{var(30\text{min})}{30 \times var(1\text{min})} \right\rvert$$ where *var*(30min) is the variance of 30-minute returns and *var*(1min) is the variance of 1-minute returns. We then calculate the average *VARRATIO* between *REPDATEs.*	TAQ
PE	Scaled Pricing Error	Calculated for each stock on each trading day as follows: $$PE = \frac{\sigma(s)}{\sigma(p)}$$ where $\sigma(s)$ is the standard deviation of the pricing error, which is assumed to follow a zero-mean, covariance-stationary process, and $\sigma(p)$ is the standard deviation of intraday transaction prices. We then calculate the average *PE* between *REPDATEs*.	TAQ
SIZE	Size	Market capitalization of a stock measured by price in month *t* multiplied by shares outstanding in month *t*, measured in $ million	CRSP
BM	Book-to-Market Ratio	Book Equity in June of calendar year, *t*, divided by market equity in December of previous calendar year, *t*-1.	CRSP, Compustat
IVOL	Idiosyncratic Volatility	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.	CRSP, Fama-French
ILLIQ	Illiquidity	Average ratio of the absolute value of daily returns to the stock daily volume in the past six months, as in Amihud (2002).	CRSP
PASTRETURNS	Past Returns	Cumulative monthly returns over the past six months.	CRSP

MONTHLY	Period before and after Markit started providing monthly total short interest data	Dummy variable that equals 1 for the period from June 2002 to December 2003; and zero for the period from January 2001 to May 2002	Markit
WEEKLY	Period before and after where Markit started providing weekly total short interest data	Dummy variable that equals 1 for the period from August 2004 to June 2006; and zero for the period from October 2002 to July 2004	Markit
DAILY	Period before and after where Markit started providing daily total short interest data	Dummy variable that equals 1 for the period from July 2006 to August 2007; and zero for the period from May 2005 to June 2006	Markit
Δ*SHORT*	Change in Short Interest	Change in short interest between two successive short interest announcement dates, scaled by stock's shares outstanding at the end of the month. In the pre-amendment period, it captures monthly changes; in the post period, it is bi-weekly changes	CRSP, Compustat
Increased Shorting	Portfolio of stocks with the greatest increase in Short Interest	Portfolio of stocks that has Δ*SHORT* above the 90th percentile at each *REPDATE*.	CRSP, Compustat
Decreased Shorting	Portfolio of stocks with the greatest decrease in Short Interest	Portfolio of stocks that has Δ*SHORT* below the 10th percentile at each *REPDATE*.	CRSP, Compustat
Small	Portfolio of Small Stocks	Portfolio of stocks that has *SIZE* in the lowest quintile (below the 20th percentile) at each *REPDATE*.	CRSP
Large	Portfolio of Large Stocks	Portfolio of stocks that has *SIZE* in the highest quintile (above the 80th percentile) at each *REPDATE*.	CRSP
LowBM	Portfolio of Low BM Stocks	Portfolio of stocks that has *BM* in the lowest quintile (below the 20th percentile) at each *REPDATE*.	CRSP, Compustat
HighBM	Portfolio of High BM Stocks	Portfolio of stocks that has *BM* in the highest quintile (above the 80th percentile) at each *REPDATE*.	CRSP, Compustat
LOANLENGTH	Holding Horizon of Short-Sellers' Positions	Average loan tenure for short-sale positions after each *REPDATE* and before the next *REPDATE*.	Markit

Δ*SHORT_MARKIT*	Change in Short Interest based on Markit	Change in short interest based on the universe of market participants covered by Markit. It is calculated as the difference between two consecutive *REPDATEs* (including the placebo *REPDATE*s), scaled by shares outstanding at the end of the month.	Markit, CRSP

Appendix B. Explanation of TAQ Data Processing and Construction of High-Frequency Measures of Informational Efficiency

This appendix explains the method used to process TAQ data and construct the high-frequency measures of informational efficiency. We first process all trades and quotes in the TAQ database from January 1, 2003 to December 31, 2012, excluding 2008. We follow Hasbrouck (1993) and exclude overnight returns. We focus solely on trades and quotes within regular trading hours, that is, between 9:30 am and 4:00 pm Eastern Time. For the processing of the trade files, we follow Boehmer and Wu (2013) and remove trades with non-positive prices or sizes. Furthermore, we require that TAQ's CORR file to equal zero, and TAQ's COND field is either blank or equal to *, B, E, J, or K. We also follow Boehmer and Wu (2013) and remove trades with a price greater than 150% or less than 50% of the price of the previous trade. For the processing of the quote files, we remove quotes with non-positive bid or ask prices or where the bid price is strictly higher than the ask price—that is, we remove cases of locked and crossed markets. We requite that TAQ's mode field is equal to 1, 2, 3, 6, 10, 12, 15, 19, 20, 27, or 28. We also follow Boehmer and Wu (2013) and require that quotes with an ask price that is greater than 150% of the bid price are excluded. For each stock, we aggregate all trades during the same second that execute at the same price, and retain only the last quote for each second, in the case that multiple quotes are reported. To combine the quote and trade file, we use the Lee and Ready's (1991) method for assigning trade directions. That is, we denote the trade as "buyer-initiated" if the trade price is greater than the prevailing mid-quote, and we denote the trade as "seller-initiated" if the trade price is less than the prevailing mid-quote.

To calculate the Variance Ratio, we first generate overlapping 1-minute and 30-minute returns for each stock in each trading day. As is customary in the market microstructure literature, we use the quote mid-point as opposed to the trade price in calculating returns. We then construct take the variance of all overlapping 30-minute and 1-minute returns for each stock each trading day and compute the variance ratio as follows:

$$VARRATIO = \left|1 - \frac{var(30\text{min})}{30 \times var(1\text{min})}\right|$$

To calculate the Pricing Error, we follow Hasbrouck (1993) and Boehmer and Wu (2013), and decompose log transaction prices, p_t, as follows:

$$p_t = m_t + s_t$$

In the equation above, m_t represents the efficient (random walk) component of the stock price. It is the expectation of the stock's fundamental value. m_t changes in response to new public information. s_t represents the pricing error, and measures temporary deviations relative to m_t. It is assumed to follow a zero-mean covariance-stationary process, however, it can be serially correlated or correlated with the innovations from m_t. The standard deviation of the pricing error, $\sigma(s)$ measures the magnitude of deviations from the efficient price and can be interpreted as a measure of informational efficiency.

To empirically estimate this model, we follow Boehmer and Wu (2013) and run a vector autoregression (VAR) system for each stock each trading day, using five lags over the following jointly determined system of variables, $\{r_t, x_t\}$, where r_t is the difference in log prices, p_t, and x_t is a vector representing trade-related variables such as, trade sign indicator—a variable which equals 1 for a buy and -1 for a sale, signed trading volume, and signed square root of trading volume. Estimating this system of equations using a VAR yields estimates of $\sigma(s)$ for each stock each trading day. We scale $\sigma(s)$ by the standard deviation of log transaction prices, $\sigma(p)$, to compute the pricing error, PE. Finally, to reduce the influence of outliers, we follow Boehmer and Wu (2013) and remove observations where $\sigma(s) > \sigma(p)$.

Table 1. Descriptive Statistics

In this table, we present the descriptive statistics for our main analysis. 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*; and 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.

	VARIABLES	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 to Earnings Announcements

In this table, we present the regression results for the short-term price reactions to earnings announcements. In Panel A, we present 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. In Panel B, we present 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* (which are defined in Table 1 and Appendix A), and include industry, year, month and day-of-week fixed effects. In column 4, we also include stock fixed effects. All regressions include a constant term, whose coefficient is suppressed for reporting purposes. 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

VARIABLES	(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. Other Short-Term Effects Around Earnings Announcements

In this table, we present the regression results for the other effects measures around 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 and Appendix A. We also include a constant term in all regression specifications, but suppress it for reporting purposes. 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.

VARIABLES	(1) *TURNOVER*	(2) *VOLATILITY*	(3) *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 to Earnings Announcements

In this table, we present the regression results for the long-term price reactions to earnings announcements. In Panel A, we 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. In Panel B, we present 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* (which are defined in Table 1 and Appendix A), and include industry, year, month and day-of-week fixed effects. In column 4, we also include stock fixed effects. All regression specifications include a constant term, whose coefficient is suppressed for reporting purposes. 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

VARIABLES	(1) *CAR*[2,61]	(2) *CAR*[2,61]	(3) *CAR*[2,61]	(4) *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) *CAR*[2,61]	(2) *CAR*[2,61]	(3) *CAR*[2,61]	(4) *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. Asymmetric Effects: Negative Earnings Announcements

In this table, we present the regression results reported in Tables 2-4, focusing on negative earnings announcements. We 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*; *NEGNEW* is a dummy variable that equals that equals 1 if the firm's earnings announcement is negative; *e* x *NEGNEW* is an interaction term between *e* and *NEGNEW*; *POST* x *NEGNEW* is an interaction term between POST and *NEGNEW*; *POST* x *e* x *NEGNEW* is an interaction term between *POST*, *e*, and *NEGNEW*. 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 and Appendix A. We also include a constant term in all regression specifications, but suppress it for reporting purposes. 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.

VARIABLES	(1) *CAR*[0,1]	(2) *TURNOVER*	(3) *SPREAD*	(4) *VOLATILITY*	(5) *CAR*[2,61]
POST x *e*	-0.0019**	-0.0009**	-0.0077	-0.0196***	-0.0051*
	(0.0008)	(0.0003)	(0.0078)	(0.0071)	(0.0028)
POST x *e* x *NEGNEW*	-0.0022**	-0.0003**	-0.0534***	-0.0229*	-0.0123**
	(0.0011)	(0.0001)	(0.0155)	(0.0119)	(0.0056)
e x *NEGNEW*	0.0015**	0.0005*	0.0481***	0.0169***	0.0080***
	(0.0007)	(0.0003)	(0.0068)	(0.0059)	(0.0030)
POST x *NEGNEW*	0.0026**	0.0004	0.0378***	0.0137	0.0101***
	(0.0010)	(0.0004)	(0.0121)	(0.0085)	(0.0039)
NEGNEW	0.0032***	0.0008*	0.0611***	0.0269***	0.0108***
	(0.0010)	(0.0005)	(0.0133)	(0.0094)	(0.0036)
POST	0.0116***	0.0011*	0.0910***	0.0077	0.0245***
	(0.0014)	(0.0006)	(0.0126)	(0.0120)	(0.0044)
e	0.0031***	0.0008***	0.0240***	0.0174***	0.0032*
	(0.0005)	(0.0002)	(0.0054)	(0.0048)	(0.0018)
Observations	59,020	59,934	59,904	59,425	56,609
R-squared	0.122	0.134	0.247	0.037	0.074
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. Alternative Measures of Informational Efficiency: Price Delay

In this table, we present the regression results from Equation (1) using alternative measures of informational efficiency which rely on the price delay measure of Hou and Moskowitz (2005). Specifically, we use the following dependent variables: in column (1), *DELAY*1 is a measure similar to Hou and Moskowitz's (2005) D1 measures of price delay, measured as one minus the ratio of the R^2 from the regression where coefficients on lagged market returns are constrained to zero and the unrestricted R^2; in column (2), *DELAY*1_*NEG* is a measure similar to *DELAY*1, except that only negative market returns are used (positive market returns are set to equal zero); in column (3), *DELAY*3 is a measure similar to Hou and Moskowitz's (2005) D3 measure of price delay, which distinguishes between shorter and longer lags of market returns and accounts for the precision of estimates on the coefficients of lagged market returns. *DELAY*1, *DELAY*1_*NEG*, and *DELAY*3 are calculated as cross-sectional averages between consecutive *REPDATEs*, therefore there is a single price delay measure corresponding to each *REPDATE*. Further details regarding the calculation of *DELAY*1, *DELAY*1_*NEG*, and *DELAY*3 can be found in Appendix A. 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 delay measures are calculated 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 year, month and day-of-week fixed effects and a constant term whose coefficient is suppressed for reporting purposes. *, **, *** indicate 10%, 5% and 1% level of significance, respectively.

VARIABLES	(1) *DELAY*1	(2) *DELAY*1_*NEG*	(3) DELAY3
POST	-0.0346	-0.0094	-0.4632
	(0.0211)	(0.0611)	(0.2949)
E	0.0300*	0.1535***	0.4747**
	(0.0177)	(0.0338)	(0.1861)
POST x *e*	-0.0470**	-0.1666***	-0.5361**
	(0.0206)	(0.0484)	(0.2208)
Observations	216	216	216
R-squared	0.225	0.200	0.259
Time FE	Yes	Yes	Yes

Table 7. Alternative Measures of Informational Efficiency: High Frequency Measures

In this table, we use high-frequency measures of informational efficiency measured as the average between the current *REPDATE* and the following *REPDATE*: in columns (1) and (2), *VARRATIO* is the variance ratio of 1-minute and 30-minute overlapping intraday returns; in columns (3) and (4), *PE* is the scaled pricing error defined as the standard deviation of the pricing error divided by the standard deviation of log intraday prices. Further details regarding the calculation of *VARRATIO* and *PE* can be found in Appendix A and B. 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 high frequency measures are calculated 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 addition to *POST*, *e*, and *POST* x *e*, we include the control variables of: idiosyncratic volatility (*IVOL),* stock's market capitalization (*SIZE),* book-to-market ratio (*BM),* past cumulative monthly returns (*PASTRETURNS)* and illiquidity *(ILLIQ).* Further details regarding the definition of these variables can be in Appendix A. All regressions include industry, stock, year, month and day-of-week fixed effects. We also include a constant term in all regression specifications, but suppress it for reporting purposes. We present ordinary least squares estimates with standard errors clustered by stock and short-interest announcement days; *, **, *** indicate 10%, 5% and 1% level of significance, respectively.

VARIABLES	(1) *VARRATIO*	(2) *VARRATIO*	(3) *PE*	(4) *PE*
POST x *e*	-0.0236***	-0.0206***	-0.0039***	-0.0041***
	(0.0009)	(0.0010)	(0.0003)	(0.0003)
E	0.0199***	0.0173***	0.0045***	0.0033***
	(0.0016)	(0.0017)	(0.0005)	(0.0005)
POST	0.0418***	0.0456***	0.0007	0.0061***
	(0.0023)	(0.0027)	(0.0007)	(0.0007)
IVOL		-0.0020***		0.0037***
		(0.0001)		(0.0000)
BM		0.0541***		0.0290***
		(0.0011)		(0.0004)
SIZE		-0.0000***		-0.0000***
		(0.0000)		(0.0000)
ILLIQ		0.0097***		0.0066***
		(0.0004)		(0.0016)
PASTRETURNS		-0.0054***		-0.0142***
		(0.0013)		(0.0005)
Observations	533,604	419,321	451,621	357,784
R-squared	0.016	0.076	0.050	0.242
Controls	No	Yes	No	Yes
Time FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Stock FE	Yes	Yes	Yes	Yes

Table 8. Market Reactions to Short Interest Announcements

In this table, we present the results from the market reactions to short interest announcements during our sample period. We form 10 portfolios based on changes to short interest (Δ*SHORT*) on each announcement 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. We skip the day of announcement because short interest is disclosed after 4:00 p.m. 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 average 4-factor alphas in the [-3,0] days prior to the short interest announcement. In Panel C, we report the average 4-factor alphas in the [1,2] days after the short interest announcement, in the pre- and post-amendment periods. 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)	(3)
Decile	SMB	3-factor Alpha	4-factor Alpha
1	0.0432***	0.0479***	0.0477***
	(0.0137)	(0.0124)	(0.0125)
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

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: pre- vs post-amendment periods

Decile	*POST*=0	*POST*=1	Diff
1	0.0171	0.0534***	0.0363**
	(0.0201)	(0.0157)	(0.0179)
10	-0.0654**	-0.1275***	-0.0621***
	(0.0286)	(0.0178)	(0.0218)
Diff	0.0825**	0.1809***	0.0984***
	(0.0277)	(0.0185)	(0.0302)

Table 9. Short Sellers' Holding Periods

In this table, we present the regression results of the impact of the regulatory amendments have on short sellers' holding periods. The table presents the regression results where the dependent variable, *LOANLENGTH* is the average loan tenure (in calendar days) for short-sale positions after the current *REPDATE* and before the next *REPDATE*. 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 *LOANLENGTH* is calculated 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 the following control variables: idiosyncratic volatility (*IVOL),* stock's market capitalization (*SIZE),* book-to-market ratio (*BM),* past cumulative monthly returns (*PASTRETURNS),* illiquidity *(ILLIQ)* and stock fixed effects. Further details regarding the definition of control variables can be found in Appendix A. All regressions include year, month, day-of-week fixed effects. We also include a constant term in all regression specifications, but suppress it for reporting purposes. 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) *LOANLENGTH*	(2) *LOANLENGTH*
POST x *e*	-9.8280***	-9.0411***
	(2.9838)	(3.2552)
POST	3.2377***	2.1909**
	(0.7576)	(0.8690)
e	9.6129***	8.7815***
	(2.9862)	(3.2575)
SIZE		-0.0012***
		(0.0002)
IVOL		-0.5024***
		(0.0843)
ILLIQ		-0.0275
		(0.0358)
BM		4.6395***
		(0.6222)
PASTRETURNS		1.0262
		(0.7028)
Observations	382,612	306,198
R-squared	0.028	0.039
Controls	No	Yes
Time FE	Yes	Yes
Stock FE	Yes	Yes

Table 10. Reward-to-Risk Ratios of Short Sellers' Positions

In this table, we present the impact of the regulatory amendments on the reward-to-risk ratio of short-sellers' positions. Markit reports the total short positions taken on by the universe of market participants it covers (*SHORT_MARKIT*). On each *REPDATE*, we form 10 portfolios based on changes in short interest in Markit (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 use the daily returns until the next *REPDATE* and calculate the average 4-factor alphas and its standard deviations for each portfolio. The table reports the reward-to-risk ratio, defined as the 4-factor alpha divided by its standard deviation. *POST* is a dummy variable that equals 1 for observations in the post-amendment period; *e* is a dummy variable that equals 1 when Δ*SHORT_MARKIT* is calculated after the end-of-month *REPDATE* and before the mid-month *REPDATE* the following month. We use Newey-West standard errors with 5 lags (reported in parentheses).

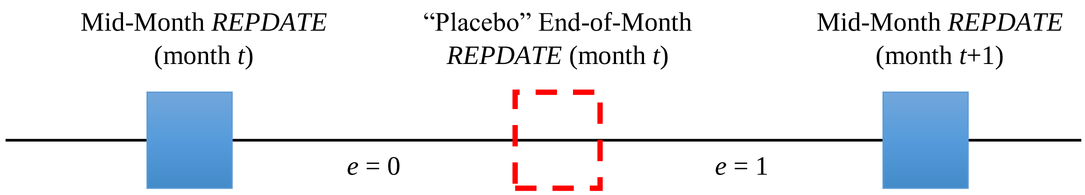
	e=0		*e=1*	
POST=0	**P1**	1.1857	**P1**	1.2400
	P10	-1.9921	**P10**	-1.6000
	P1-P10	1.8453	**P1-P10**	1.5370
POST=1	**P1**	1.2361	**P1**	1.2051
	P10	-2.0381	**P10**	-2.4476
	P1-P10	2.0897	**P1-P10**	2.4894

Table 11. Short Selling Activity

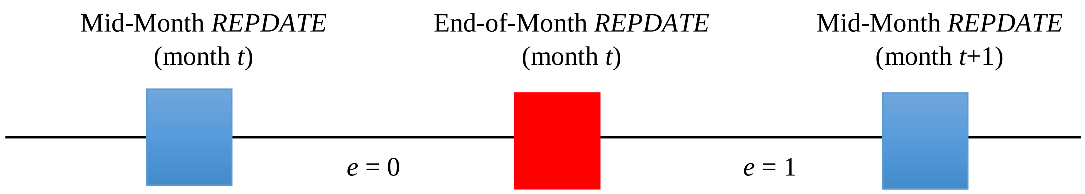
In this table, we present the impact of the regulatory amendments on short-selling activity. The dependent variable used is Δ*SHORT_MARKIT*, which is the change in total short positions taken on by the market participants covered by Markit between two consecutive *REPDATEs* (including the placebo *REPDATE*), scaled by shares outstanding at the end of the month. 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 Δ*SHORT_MARKIT* is calculated 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 the following control variables: idiosyncratic volatility (*IVOL),* stock's market capitalization (*SIZE),* book-to-market ratio (*BM),* past cumulative monthly returns (*PASTRETURNS),* illiquidity *(ILLIQ)* and stock fixed effects. Further details regarding the definition of control variables can be found in Appendix A. All regressions include year, month and day-of-week fixed effects. We also include a constant term in all regression specifications, but suppress it for reporting purposes. 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) Δ*SHORT_MARKIT*	(2) Δ*SHORT_MARKIT*
POST x *e*	0.1582***	0.1632***
	(0.0427)	(0.0482)
POST	-0.1205	-0.1271
	(0.0734)	(0.0826)
e	-0.1244***	-0.1282***
	(0.0394)	(0.0448)
SIZE		-0.0000***
		(0.0000)
IVOL		-0.0006
		(0.0007)
ILLIQ		0.0006***
		(0.0002)
BM		-0.0193***
		(0.0054)
PASTRETURNS		0.0035
		(0.0137)
Observations	345,458	261,958
R-squared	0.008	0.009
Controls	No	Yes
Time FE	Yes	Yes
Stock FE	Yes	Yes

Figure 1. Diagrammatic Explanation of Empirical Methodology



Pre-Amendment Period



Post-Amendment Period

The identification in our empirical design 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

In this figure, we present the price reactions to short interest announcements. On each announcement date, 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. In this figure, we show 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. Short interest is publicly disclosed after 4:00 p.m. at t = 0.

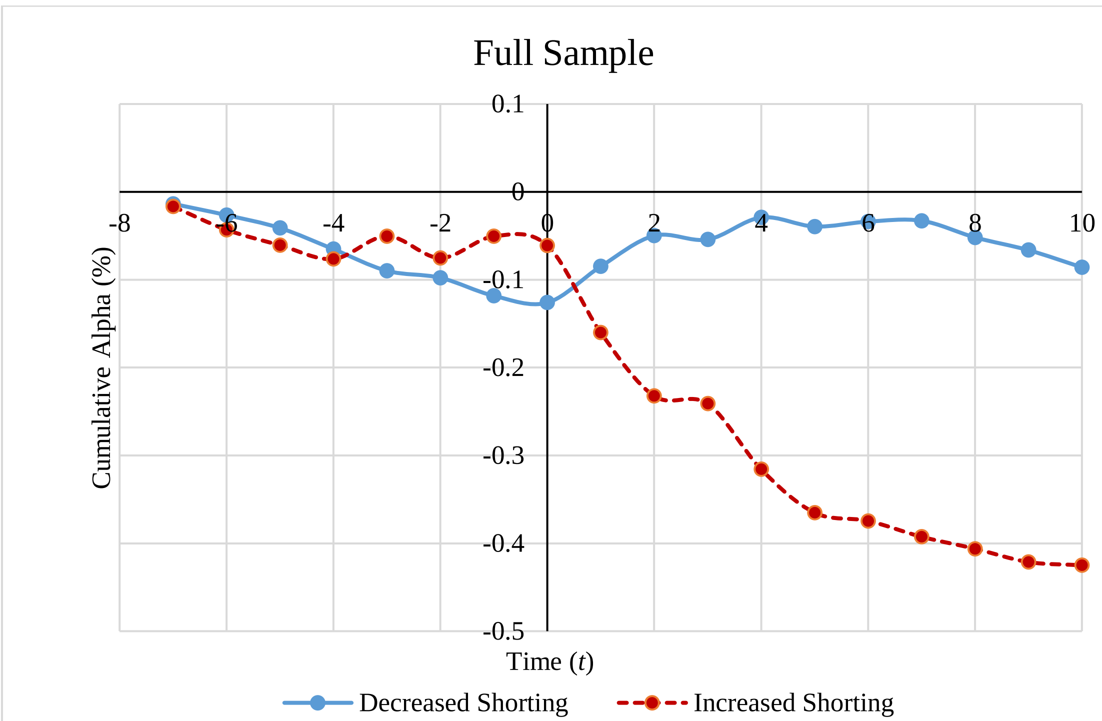
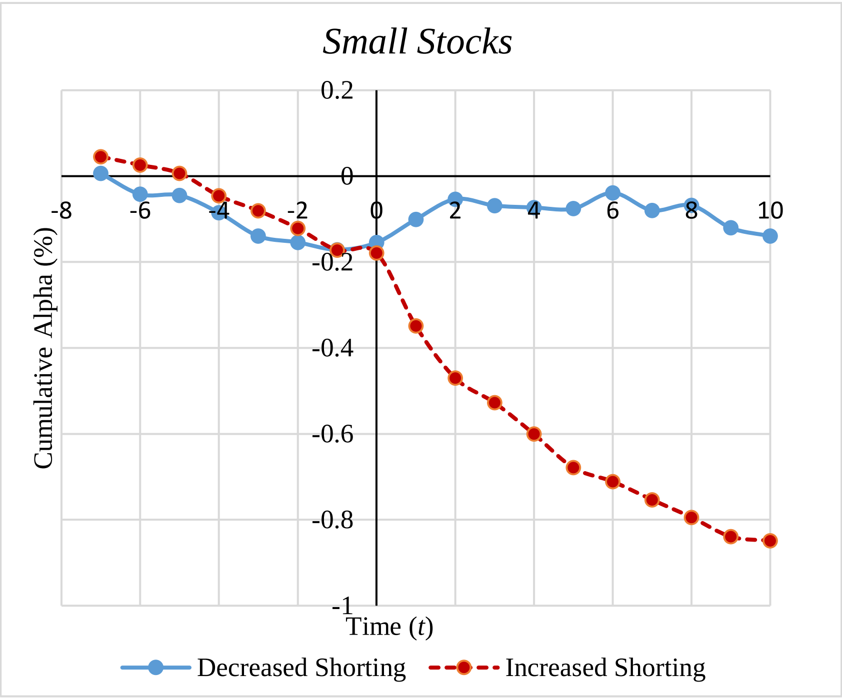
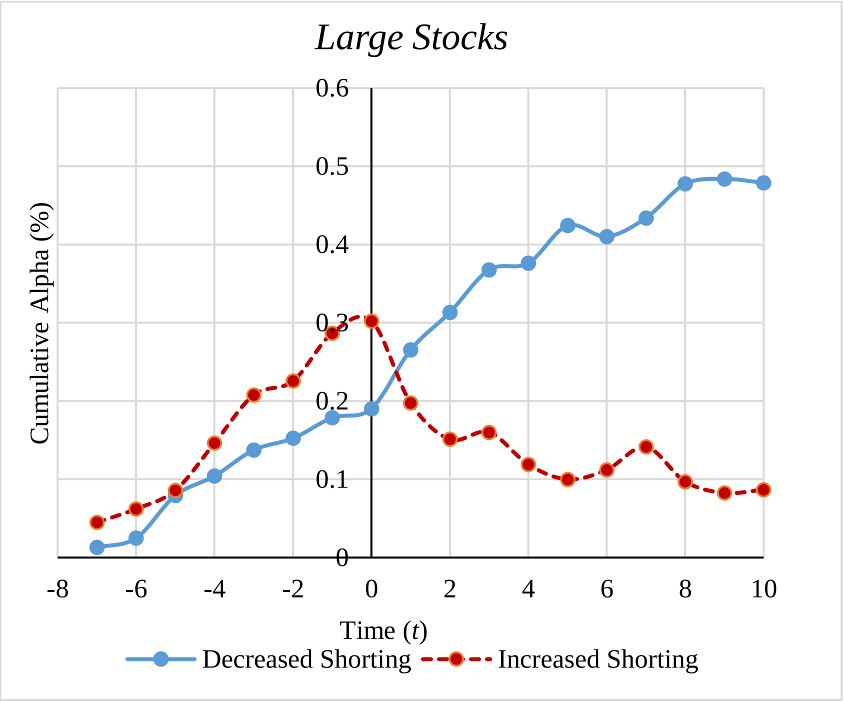


Figure 3. Market Reactions to Short Interest Announcements: Cross-Sectional Analysis

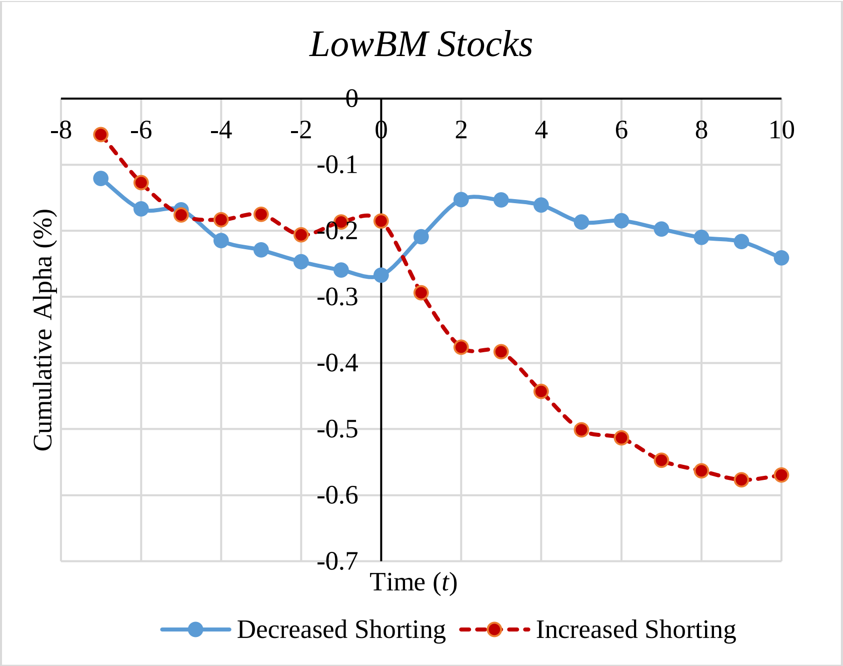
In this figure, we present cross-sectional analysis in price reactions to short interest announcements. On each announcement date, we form quintiles according to stock market capitalization (*SIZE*) or book-to-market ratio (*BM*). Within each quintile, we form 10 portfolios based on (Δ*SHORT*). Δ*SHORT* 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* and *Large* are the bottom and top quintiles formed based on *SIZE* (Panel A), and *LowBM* and *HighBM* 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. Short interest is publicly disclosed after 4:00 p.m. at t = 0.

Panel A. Small versus Large Stocks





Panel B. Low BM versus High BM stocks



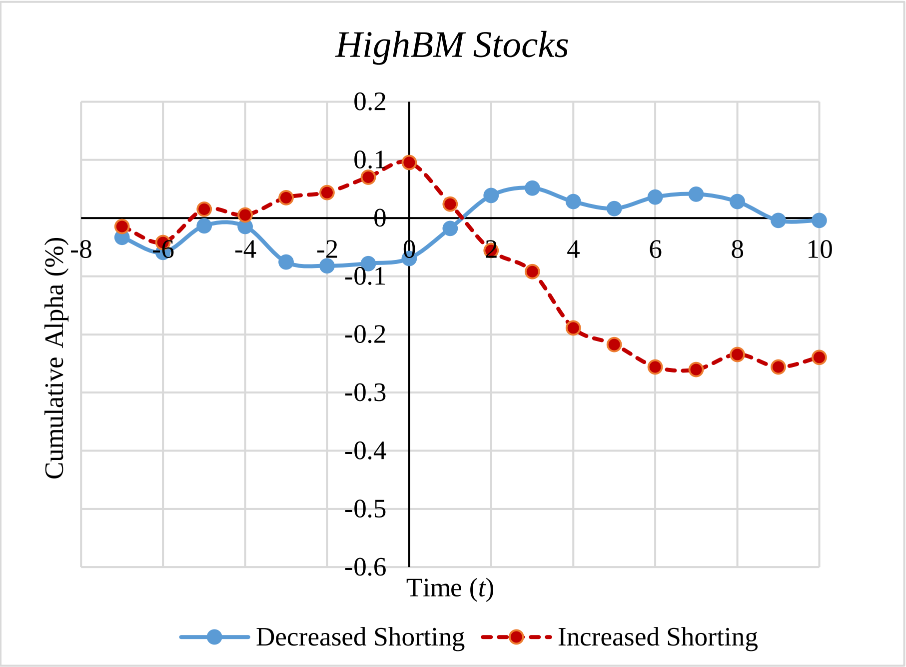
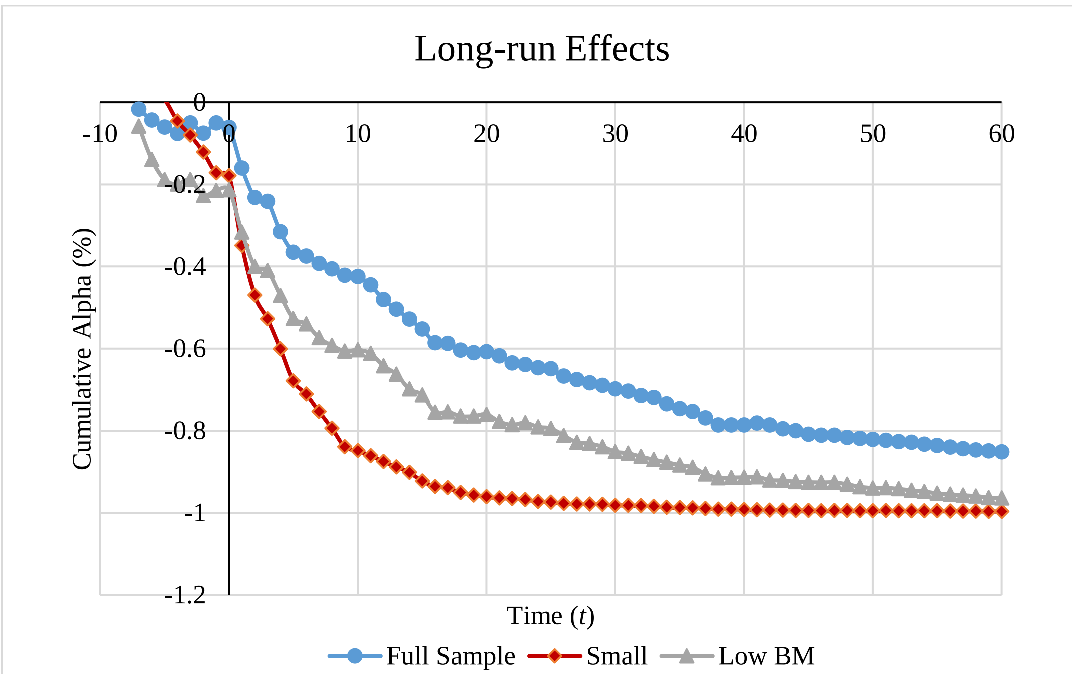


Figure 4. Market Reactions to Short Interest Announcements: Long-run Effects

In this figure, we present the long-run price reactions to short interest announcements. On each announcement date, 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. This 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. Short interest is publicly disclosed after 4:00 p.m. at t = 0. The blue line shows cumulative 4-factor alphas for the *Increased Shorting* portfolio in the full sample. The grey and red lines show the cumulative 4-factor alphas for *Increased Shorting* portfolio within *Small* (stocks with market capitalization in bottom quintile) and *LowBM* (stocks with book-to-market ratios in bottom quintile), respectively.



Internet Appendix to Show Us Your Shorts!

Internet Appendix Table IA.1. Robustness: Alternative Sample Periods

In this table, we present the regression results reported in Tables 2-4 using alternative sample periods. In Panel A, we present the regression results using a [-48,48] month event window around the regulatory amendments on September 7, 2007, excluding 2008. In Panel B, we present the regression results using a [-48,60] month event window around the regulatory amendments on September 7, 2007, excluding 2008. In both panels, we 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 and Appendix A. We also include a constant term in all regression specifications, but suppress it for reporting purposes. 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)

VARIABLES	(1) *CAR*[0,1]	(2) *TURNOVER*	(3) *SPREAD*	(4) *VOLATILITY*	(5) *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

Internet Appendix Table IA.2. Robustness: The Timing of Earnings News

In this table, we present the regression results reported in Tables 2-4 for a subsample of firms, which tend to announce their earnings in the same time 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 and Appendix A. We also include a constant term in all regression specifications, but suppress it for reporting purposes. 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

Internet Appendix Table IA.3. Changes in the Frequency of Markit Data Availability

In this table, we present the regression results analyzing the impact of changes in the frequency in availability of Markit data. All the changes in the frequency of availability of Markit data all occurred in the pre-amendment period. The dependent variables in columns (1), (3), and (5) are *CAR*[0,1], which 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 dependent in columns (2), (4), and (6) are *CAR*[2,61], which 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. Regressions use three experiments. First one occurred in June 2002, where Markit first started providing monthly data; second one is on August 2004, when reporting frequency of Markit data increased from monthly to weekly; and the third one is on July 2006, when the reporting frequency increased from weekly to daily. The explanatory variables include: *MONTHLY* is a dummy variable that equals 1 for the period after the first experiment and before the second experiment; *WEEKLY* is a dummy variable that equals 1 for the period after the second experiment and before the third experiment; and *DAILY* is a dummy variable that equals 1 for the period after the third experiment and before the SEC's rule amendment implemented in September 2007. Each regression uses an estimation window that is symmetric around the experiment date and ensures no overlapping observations with the consecutive experiment. More detailed definitions of these variables are in Appendix A. 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 and Appendix A. We also include a constant term in all regression specifications, but suppress it for reporting purposes. 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)	(6)
VARIABLES	*CAR*[0,1]	*CAR*[2,61]	*CAR*[0,1]	*CAR*[2,61]	*CAR*[0,1]	*CAR*[2,61]
MONTHLY	0.0013	-0.0087**				
	(0.0009)	(0.0044)				
WEEKLY			0.0001	0.0013		
			(0.0014)	(0.0051)		
DAILY					-0.0021	0.0043
					(0.0016)	(0.0068)
Observations	20,761	20,800	27,931	27,505	15,476	15,144
R-squared	0.066	0.079	0.105	0.083	0.111	0.051
Controls	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Stock FE	Yes	Yes	Yes	Yes	Yes	Yes