Textual Analysis of Short-seller Research Reports, Stock Prices, and Real Investment*

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Abstract

We construct a comprehensive database of short-sell research reports and investigate to what extent investors pay attention to these reports. We find that, on average, target firms earn abnormal returns of -4% on the publication day, while the subsequent price revisions equal -20% and take up to 6 months to materialize. Analysts also react by lowering their price targets. By applying textual analysis, we show that a large percentage of the text relates to the revelation of accounting fraud. We document that firms mentioned in the reports end up significantly reducing their real investment and stock issuances. On average, each report is associated with a reduction of corporate investment equal to $118 million, and stock issuances equal to $179 million. Our findings suggest that short-seller research has significant consequences, both financially and in real terms.

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1 Introduction

Investment firms that produce short-sell research reports have recently received much attention in the media, and important questions have been raised regarding the financial and real consequences of such articles. However, while many papers have been dedicated to studying the potential benefits and costs of short-selling, few focus on the impact and value of short-sell research. In this paper, we fill this void and show that short-sell research reports and their publication provide a valuable laboratory to understand better the importance of short selling for real economic outcomes.

In particular, the paper makes the following contributions. First, we construct and make publicly available a comprehensive database of short-sell research reports. We collect the data using a combination of web-scraping and human verification, which ensures the accuracy of the data. We find that firms mentioned in short-sell research are younger and larger on average. Further, the reports target firms that issue more stocks and make more investments while having lower book-to-market ratios. Finally, by conducting textual analysis on the reports, we find that around 60% of them address fraud or financial misconduct.

Second, and consistent with the existing literature, we find short-sell reports have a large impact on stock prices and investor attention.[1] Investors respond to the reports by showing that market measures of attention, such as trading volume, as well as information demand measures, such as the number of downloads of companies filings, spike right around the report release date. Furthermore, the abnormal return equals -4% on the publication day, and we show that prices continue to slowly decline for up to 6 months, resulting in a cumulative total effect of -24%.

Since the reports are endogenous, one valid concern is that short-seller research firms are pre-selecting companies that would have negative returns anyways. To address this concern, we conduct the following test: we split the sample into firms with positive abnormal returns or negative abnormal returns before the publication date. We find that the cumulative abnormal returns after the publication day are negative regardless of the performance before

[1] See for example Ljungqvist and Qian (2016), Chen (2016), Zhao (2020), and Appel and Fos (2020).

publication. Therefore, we provide novel evidence that price momentum does not drive the decline in the market value upon the publication of the reports.

Most importantly, we provide new evidence demonstrating that short-sell research and its subsequent stock-market effects are associated with significant real economic impact. Companies reduce their capital and R&D expenditure by up to 2% of assets, which translates to an average value of $118 million in corporate investment per report. We attribute the decrease in investment to a higher cost of capital as in the model of van Binsbergen and Opp (2019). Furthermore, firms mentioned in the reports seem to respond to the downward price correction by significantly reducing net stock issuances equal to $179 million on average.

One concern with the results regarding the economic impact could be that because short-sellers do not randomly select firms when deciding to write a report, there could be a hidden unobservable variable that makes firms more likely to be a report's target and decrease activity in the future. In other words, short-seller research firms could select companies because they will decrease their real activities. While it is naturally impossible to control for a time-varying firm-specific hidden variable, we do our best to show this scenario does not seem likely. We conduct a battery of tests to reject any obvious problem. First, we control for firm fixed effects, time fixed effects, and observable characteristics that predict real activity, so any hidden driving both the selection and the real effects would have to be time-varying, unobservable, and idiosyncratic.

Second, we provide evidence that the decrease in real activity appears to surprise market participants. First, we document that analysts decrease their expectations about the firms only *after* the release of the short-sell reports. Furthermore, we look into managers' future earnings and sales estimates to check whether target firms tend to have less planned investments and growth before the short-sellers research reports' publication.[2] We find no evidence indicating that managers lower their economic outlook before the publications of the short-seller research. Thus, the expectation surprise combined with the sharp decline in price makes a strong argument showing that the change in investment and stock issuance is unexpected.

[2]We obtain managers' earnings and sales forecasts from the I/B/E/S guidance database.

Third, we study whether target firms who experienced more downward price correction induced by the short-sellers research reports have less stock issuance and investment, consistent with an increase in the cost of capital.[3] We break the target firms into two groups where the breakpoint is the median value of their cumulative alpha after the publication dates of short-seller research reports. We find that target firms with larger negative alphas have fewer investments than firms with smaller negative alphas. The finding suggests that the downward price correction induced by short-seller research plays an influential role in driving the investment of target firms.

Finally, we use firms that commit accounting frauds but have not been identified by the short-seller research reports as a 'control' group.[4] Importantly, most short-sell research reports contain accounting fraud allegations, as shown by our textual analysis. Consistent with our hypothesis, we find that only the firms whose accounting frauds are mentioned by short-seller research experience a downward change in real activities. While we are fully aware of the endogeneity of the short-sell research, and hence, we only speak about correlation and not causality, we find no evidence consistent with the hypothesis of short-seller research firms selecting the firms because their investment will decline.

Related Literature

We contribute to the literature of short-selling, hedge-fund activism, information transmission, and the real effects of financial markets. There is extensive literature documenting the impact of short-selling and short-sales constraints on the stock market. Our paper complements the existing literature on short-selling and its effect on financial markets by using a specific laboratory: the release of short-sell reports. Importantly, we provide novel evidence of the association between short-sell reports and real activities.

Our paper builds on the contribution of Ljungqvist and Qian (2016). Using data for 124 short-sale campaigns in the United States, they show that investors respond strongly to the information release, with spikes in SEC filing views, volatility, order imbalances, realized

[3] We use CAPM alpha to control for economy-wide changes in the discount rate.
[4] We obtain accounting fraud data from Audit Analytics' (AA) earnings restatement database.

spreads, turnover, selling by the longs, and share prices falling. Using a more extensive sample, we complement their research by focusing on the long-term effects of the short-seller reports and their impact on real allocations. Lamont (2012) shows that firms use a variety of methods to impede short selling, including legal threats, investigations, lawsuits, and various technical actions, but as explained by Ljungqvist and Qian (2016) releasing short-sell reports is a provides a method to increase price convergence.

There is an increasing amount of attention literature studying the effects of short-seller reports on the financial market. For example, Chen (2016) finds that the three-day cumulative abnormal returns are more negative when the reports allege more severe misconduct of the firms and that short-seller tend to target firms with good financial outlook but accounting red flags. Additionally, non-targeted firms also experience losses in value following short-seller reports. Similarly, Zhao (2020) finds that activist short-sellers tend to target opaque firms while non-activist short-sellers generally tend to avoid such firms. Moreover, opaque targets experience about three times as negative abnormal returns in both the short and long term as non-opaque targets, suggesting that, on average, activist short-sellers conduct informative shorts. Furthermore, Appel and Fos (2020) examine the role of strategic communication in public short-selling campaigns by hedge funds and claim the effects on the returns are driven by campaigns that feature specific allegations rather than general claims of overvaluation. Finally, Brendel and Ryans (2021) study how and when firms respond to the short-seller research report.

Related, Gillet and Renault (2018) analyze market reactions to negative tweets and reports published on the Internet by an activist short seller. They find that the market reaction to tweets is more substantial when a company is mentioned for the first time on Twitter and that traders who manage to identify the information on the short seller's website before the dissemination of the same news on Twitter can generate much greater abnormal returns.

On the theoretical motivation of releasing short-sell reports, Kovbasyuk and Pagano (2015) develop a theoretical model that shows that an arbitrageur identifying several mispriced assets will advertise a single asset and overweight it in his portfolio. Liu et al. (2017) develop a two-period Kyle (1985) type model in which an informed short-horizon investor

strategically discloses private information to enhance price efficiency and show that information disclosure is optimal when the scope of private information is large and when the large investor has a high reputation.

Jiang et al. (2020) provides a systematic literature review that studies the determinants of short selling, and the implications for information distribution, real economic decisions, financial reporting, and external auditing emphasize that penetrating the information 'black box' and positioning research regarding the information that short sellers use and how they use it are necessary to advance the short-selling literature.

Desai et al. (2002) examine the relationship between the level of short interest and stock returns and find that heavily shorted firms experience significant negative abnormal returns after controlling for the market, size, book-to-market, and momentum factors. Asquith et al. (2005) find that short-sale constrained stocks underperform during the period 1988–2002. Using institutional ownership as a proxy, Nagel (2005) finds that short-sale constraints help explain cross-sectional stock return anomalies.

Diether et al. (2009) examine short selling in US stocks based on new SEC-mandated data for 2005 and find that short sellers increase their trading following positive returns and they correctly predict future negative abnormal returns. Furthermore, short-selling activity is strongly positively related to past returns. Boehmer et al. (2008) find that stocks with relatively heavy shorting underperform lightly shorted stocks by a risk-adjusted average of 1.16% in the following 20 days of trading and conclude that short sellers as a group are extremely well informed. Engelberg et al. (2012) find that a substantial portion of short sellers' trading advantage comes from their ability to analyze publicly available information including all corporate news events.

Using proprietary data on millions of trades by retail investors, Kelley and Tetlock (2017) provide the first large scale evidence that retail short selling predicts negative stock returns. Jank et al. (2021) study how disclosure requirements for large short positions affect investor behavior and security prices. Wang et al. (2020) show that shorting flows remain a significant predictor of negative future stock returns during 2010–2015, when daily short-sale volume data are published in real time. Jones et al. (2016) show that after specific disclosures, short-

run abnormal returns are insignificantly negative, but 90-day cumulative abnormal returns are a statistically significant -5.23%.

Our paper also relates to the large literature on the real effects of capital market. Importantly, we provide novel evidence that the release of information and the subsequent stock market impact has a direct effect on the real investment decisions of the firm, as well as in their financing decisions. Regarding the real effects, Stein (1996) explores how companies should determine hurdle rates in the presence of market irrationalities. Baker et al. (2003) show that firms that need equity financing are more likely to change their behavior in response to nonfundamental movements in stock prices.

Massa et al. (2015) finds that short selling forces managers to reduce earnings management. Wang et al. (2018) show that short sellers play a disciplinary role in reducing insiders' opportunistic selling.

Gilchrist et al. (2005) argue that firms can exploit bubbles to issue stock and increase real investment, and document that earnings forecast dispersion is associated with an increase stock issuance and real investment.[5] Goldstein and Guembel (2008), Goldstein et al. (2011) and Goldstein et al. (2013) develop models where trading affects investment and policy decision. Bond et al. (2012) provide a comprehensive review of the literature. Warusawitharana and Whited (2016) develop a model in which they show that the impact of misvaluation is larger for small firms. van Binsbergen and Opp (2019) provide a quantitative model to assess the impact of incorrect prices on the investment behavior of firms.

Finally, we also contribute to the literature on underreaction of news by providing novel evidence of how long negative news take to be fully incorporated in the stock price. Daniel et al. (1998), Barberis et al. (1998), and Hirshleifer (2001) among others develop economic models that allow for underreaction. Poteshman (2001), Ikenberry and Ramnath (2002), Kadiyala and Rau (2004), Baker and Wurgler (2007), Milian (2015), Cen et al. (2017), Atilgan et al. (2020) document underreaction.

[5] In contrast, Bakke and Whited (2010) develop a novel econometric framework and find no effects.

2 Background: Short-sellers' Research and Target Firms

2.1 Background

Short-seller research companies publish research on public companies and often take positions that reflect their research. In many cases, these research reports attract media attention, that at times is polemic. For example, the Wall Street Journal documents that short-sell researchers often attract so much attention that they get personally threatened.[6]

As another illustration, Fortune magazine dedicates an entire article about short-seller reports. They feature a short-seller report by Hindenburg Research that divulged that Nikola, the electric vehicle company, misled the public by showing a video of a truck cruising through the high desert outside Salt Lake City. The short-seller research firm got a tip that the video was staged and "the truck wasn't traveling under its own power [...] it had been towed to the top of a hill. The person at the wheel then popped it into neutral and started it on its journey downhill—slowly at first, then accelerating."

On Sept. 10, Hindenburg Research published a short-sell report about Nikola. Nikola defended itself the following day, saying that the article contained "false and misleading statements" hired counsel to "evaluate potential legal recourse." Nevertheless, in a regulatory filing in November, the company revealed that the Justice Department had issued grand jury subpoenas against Nikola and its founder and executive chairman. Since the research release and until Fortune's article publication date, Nikola's stock fell by 30%, and the chairman resigned.[7]

While these reports attract attention from the business media, there is relatively little academic work that quantifies the real and financial effects of these reports. To fill this void, we assemble a comprehensive database of publicly available short-sell research reports.

[6] https://www.wsj.com/articles/gamestop-stock-short-squeeze-ugly-side-11611750250

[7] https://fortune.com/longform/short-selling-stock-market-bets-hindenburg-viceroy-muddy-waters/.

2.2 Data Sample

Our sample of short-sell research reports includes the reports publicly released by Bonitas Research, Citron Research, Viceroy Research, J Capital Research, Buceph Research, Blue Orca Capital, GMT Research, Spruce Point Capital Management, and Muddy Waters.

We use a combination of web-scraping and human verification to download all research reports from these short-sellers' websites with the initial publication dates recorded. Then, we use tickers from these reports and merge them with the Center for Research in Security Prices (CRSP) database to match them with PERMNO codes. As a result, we are able to match 463 short-sale reports of 274 unique firms listed in NYSE, NASDAQ, and AMEX.[8] Our first observation is from May 9, 2005, and the last observation is from December 28, 2020.

2.3 Textual Analysis

First, we start by running textual analysis on the universe of these reports and we find that around 60% of these reports contain allegations of fraud or financial misconduct.[9] Then, we proceed by using topic models to study what kind of story the research reports are providing. We use Latent Dirichlet Allocation (LDA), a standard Bayesian unsupervised algorithm. LDA describes each document as a distribution over topics, and each topic as a distribution over words. Consequently, LDA provides a quick summary of the topics that the collection of documents describe and what percentage each document discusses each topic.[10]

[Insert Figure 1 about here]

The topic model reveals that companies spend a considerable percentage of the reports discussing accounting information and fraud. Figure 1 plots the result of running LDA with

[8] Some firms have multiple short-sale reports on different dates.

[9] We say that a report addresses fraud or financial misconduct if it contains any of the following words or their grammatical variation: "false", "fake", "fraud", "earnings management", "illegal", "dubious", "accusation", "suspect", "questionable", "audit", "fail to disclose", "pump (the stock)".

[10] See Lopez-Lira and Lopez Lira (2019) for a detailed overview of the algorithm.

five topics. Each cluster of words corresponds to a different topic. Bigger words correspond to a higher than average probability of occurring within that topic. Topics one, four, and five discuss accounting information. Topic two discusses fraud, particularly in connection with China. Topic three corresponds to disclaimer information. Figure 2 shows the average percentage of words (per report) that firms dedicate to each topic.

[Insert Figure 2 about here]

2.4 Firms Types

We also study what types of firms are more likely to be targeted by short-seller research reports. We consider firm characteristics including age, log of firm size, net stock issuance, log of book-to-market ratio, investment-to-asset, changes in property, plant and equipment (PPE) and inventory, and sales growth. We obtain stock-level data from CRSP and firm-level accounting data from Compustat. The variables are as follows:

1. Age: the month difference between current month and the first month of a firm' stock appear in CRSP.

2. Firm Size: Price times shares outstanding at the end of December.

3. Net stock issuance (NSI): The natural logarithm of the ratio of the split-adjusted shares outstanding at the fiscal year ending in t to the split-adjusted shares outstanding at the fiscal year ending in t-1,

4. Book-to-market ratio (BM): Book equity (defined as in Fama and French (1993)) for the fiscal year ending in year t divided by the ME at the end of December of t.

5. Gross profitability to assets(GP): Total revenue minus cost of goods sold divided by total assets.

6. Investment-to-asset (IA): Total assets for the fiscal year ending in t divided by total assets for the fiscal year ending in t-1 minus 1.

7. Capital and R&D Expenditure (CAP_RD): Capital expenditure and R&D expenses divided by lagged total assets.

8. Sale Growth (SG): Net Sales for the fiscal year ending in t divided by net Sales for the fiscal year ending in t-1 minus 1.

9. Changes in PPE and inventory (Δ PI/A): Changes in gross property, plant, and equipment plus changes in inventory scaled by lagged total assets.

Having obtained these characteristics, we measure the difference between the short firms' characteristics and the cross-sectional mean/median of other firms' to study what types of firms are more likely to be subject to short-sellers research. Specifically, for each target firm, we compare their characteristics in the year prior to the publication dates of the research reports to the cross-sectional mean/median of other firms'.[11] As such, we can infer what types of firms are more likely to be targeted by short-sellers.

Table 1 presents the summary statistics of the differences in these variables. We find that, on average, the target firms are younger and larger than other firms. The target firms also issue more stocks, have higher profitability and higher real investment than other firms. The book-to-market ratios are also lower for target firms, indicating that growth firms are more likely to be mentioned in the short-seller research report.

[Insert Table 1 about here]

3 Price Impacts of Short-seller Research

What is the impact of short-seller research reports on stock prices? As discussed earlier, such reports often generate considerable media attention and so one may expect price drops upon the revelation of this information. To study price impact, we calculate the abnormal returns

[11] We only count once a firm if it has multiple short-sellers research report in a year.

of stocks on the publication date of the short-seller research reports. The abnormal return for stock i on day t ($abr_{i,t}$) is defined as,

$$\text{abr}_{i,t} = \text{ret}_{i,t} - (\hat{\alpha} + \hat{\beta} \times \text{mktrf}_t) \tag{1}$$

in which ret is the daily return and $mktrf$ is the market excess return defined as in Fama and French (1993).

Figure 3 plots the distribution of the abnormal returns (alphas hereafter) of stocks on the publication day of short-sell reports. The distribution is negatively skewed since most alphas are negative. Table 2 reports the summary statistics of alphas. On average, we find that stocks earn a negative alpha of 4.5% on the publication day, an economically large magnitude. Moreover, a t-statistic of -8.206 indicates that the negative average alpha is statistically different from zero.

[Insert Figure 3 about here]

Figure 4 (a) plots the value-weighted average of the cumulative daily alphas of the target firms in a year-long window (250-trading days) after the publication day. A visual inspection indicates a downward trend in the cumulative alphas. Further price revisions take up to 6 months to fully materialize, leading to an accumulated average effect of -24%. Figure 4 (b) shows that the average market value declines in a year's time by around $1 billion, measured as the cumulative alpha times the average market values of target firms. The decline in the market value does not seem to be driven by investor sentiment, since there is no pattern indicating a reversal in the market value. In contrast, the decline in market value is more likely driven by changes in fundamentals (e.g., accounting frauds) as identified by the short-sell research reports.

[Insert Table 2 about here]

One other possibility that is worth exploring is that the stock prices of targeted firms

start their decline before the publication day of the research reports. Combining such trends with a momentum type continuation of the price decline could potentially provide a different interpretation of our results, where the research reports do not reveal information, and their publication simply coincides with an already existing negative time trend.

To alleviate this concern, we sort sample stocks into two groups. Stocks in the first group have positive cumulative alphas before the publication day, whereas stocks in the second group have negative alphas. Next, we estimate the value-weighted cumulative alpha in each group. Figure 5 plots the cumulative alpha for each group. We find that regardless of a positive or a negative past alpha, the cumulative alpha after the publication day is negative. Therefore, our finding that stock prices are negatively impacted by short-seller research reports cannot be explained by momentum-type effects, and is consistent with the reports containing information regarding the stocks' fundamental value.

[Insert Figure 5 about here]

Next we explore whether return volatility increases when short-seller research reports are published. We calculate the daily return volatility for stock i on the day t as a rolling window (15 trading days) of the standard deviation of i's daily returns. We then calculate the value-weighted average of return volatility of firms mentioned in the research reports.

Figure 6 plots this average volatility for the targeted firms. Volatility spikes on the event day and the daily volatility reaches its highest point at 0.036 after five days of the publications of the short-seller research reports. Further, we can visually verify that a structural break occurs on the publication day for the constant level of return volatility. The mean of the return volatility is higher during the post-publication periods than during the pre-publication periods.

[Insert Figure 6 about here]

4 Short-seller Research and Real Activities

4.1 Impacts of Short-Seller Research on Firms' Real Activity

What is the impact of short-seller research reports on the real economic activity of the targeted firms? Grullon et al. (2015) find that relaxing short-selling constraints cause stock prices to fall. Small firms react to these price changes by reducing equity issuances and real investment. Since the presence of short-seller research also results in a downward price correction for their target firms, we explore in this section several hypotheses related to stock issuances and real investment.

First, we explore whether firms have lower net stock issuances after short sell research reports. Our empirical analysis is motivated by the literature on managerial market timing: firm managers tend to issue more stocks when their firms are overpriced (Baker and Wurgler (2013)). Since the short-sell reports result in a downward price correction for the overpriced firms, we expect their managers to issue fewer stocks.

Second, we explore whether firms exhibit lower rates of real investment, thereby shedding light on the quantitative model provided in van Binsbergen and Opp (2019) where equity prices have an important real feedback effect on real investment. More specifically, firms who are overvalued tend to invest more since their cost of equity is low, and a downward price correction could push up the cost of equity, leading to lower real investment rates.

To explore how firms' real activities change after the publications of short-sellers research reports, we measure the difference in stock issuances and investments between year t when a short-selling report comes out and year t+1.[12] For example, if a company's short-selling report is published on 25 June 2018, we then measure the real-activity change between 2018 and 2019.

Table 3 presents the change of firms' real economy activities after the publications of their short-sell reports. Consistent with our conjecture, we find that the report publications cause firms to issue fewer stocks and invest less. On average, net stock issuances drop by 2.2% of total shares outstanding. Sales growth goes down as well, indicating that targeted firms

[12]For firms with multiple short-sell research reports in one year, we only count once these multiple reports.

experience lower growth compared to before the report was issued. Moreover, real invest measured as the ratio of investment-to-assets, capital, and R&D expenditure, and changes in PPE and inventory are 23.1%, 2.5%, and 3.7% lower, respectively.

[Insert Table 3 about here]

One concern related to the results presented above is that the reports may be written at times where firms who are not subject to short-seller research reports also invest less and issue fewer stocks. That would imply that the downward change in the real activities is occurring at the aggregate market level rather than at the firm level. In this case, it might not be the short-seller research that drives the declines in the target firms' investments and stock issuance.

To explore this potential explanation, we use a standard difference in differences regression with firm fixed effects (see Wooldridge (2010)).[13] This standard diff-in-diff approach measures better the effect of the research report since it compares the values of companies with a report to those without reports while controlling for any aggregate variation in real activity using time-fixed effects. We also control for individual fixed effects for any individual unobserved variation that is constant through time. We remark that the short-seller reports are endogenous, but adding standard controls does not seem to suggest that the selection effect is driving the results.

Hence, we run a panel OLS regression of real investment variables on four dummy variables: $D_{1,i,t}$ that take the value of one if a firm has a short-sale report written about them in the past twelve months; $D_{2,i,t}$ that takes the value of one if such a report is written in the past 12-24 months; $D_{3,i,t}$ that takes the value one if such a report is written in the past 24-36 months; $D_{4,i,t}$ that takes the value one if such a report is written in the past 36-48 months.

$$Real\_activity_{i,t} = \beta_1 D_{1,i,t} + \beta_2 D_{2,i,t} + \beta_3 D_{3,i,t} + \beta_4 D_{4,i,t} + Year_t + Firm_i + \epsilon_{i,t}, \quad (2)$$

[13]Naturally, because the writing and publication timing of the short-sale research reports is endogenous, we shy away from causality statements.

where $Year_t$ and $Firm_i$ denote time and firm fixed effects, respectively. Since the dummy variable is zero for firms who are not subject to short-sell research reports, the coefficient estimate on this variable tells us how short-selling firms change their real activities relative to other firms.

Table 4 reports the results of this panel OLS regression. We find significantly negative coefficients of -0.133 and -0.026 on the dummy variable $D_{1,i,t}$ for investment-to-assets and capital and R&D expenditure, respectively. Companies reduce their capital and R&D expenditure by up to 2% as a percentage of assets, which translates to an average value of $118 million in corporate investment than other firms in the subsequent year. The coefficient estimate is -0.035 (with t-statistic of -4.434) indicates that firms with short-seller research reports experience 3.5% more negative changes in net stock issuance than other firms in the subsequent year value. By multiplying this percentage change with the average market value of target firms, we find an average decline of $179 million in stock issuances. The effect of the report in the two year is given by $D_{2,i,t}$, $D_{1,i,t}$, on the third year by $D_{3,i,t}$ and on the fourth year is $D_{4,i,t}$.

[Insert Table 4 about here]

In the multivariate Panel regression, we control for short interest and firm size following Grullon et al. (2015). In addition to short interests and firm size, we also consider the total asset as a control variable.

Table 5 reports the panel OLS regressions with these control variables. Overall we find consistent results that firms with short-seller research reports make fewer investments. Moreover, after considering control variables, we find more significantly negative coefficients on sale growth and changes in PPE and inventory.

[Insert Table 5 about here]

4.2 Long-Term Effects in Real Activities

To study the long-term effects of the reports on real activity, we consider a window of eight years (with four years pre- and post-publications of the research reports). That is, for each firm with a research report published in the fiscal year ending in year $t+0$, we measure the difference between its real activities in year $\{t-4, t-3, t-2, t-1, t+1, t+2, t+3, t+4\}$ and its real activities in year $t+0$.

Figure 7 plots these differences in real activities for an 8-year window with a blue bar as the confidence interval. We find downward trends in the changes of net stock issuance, investment-to-asset ratio, capital and R&D expenditure, changes in PPE and inventory, and sales growth. Moreover, we find statistical significance for changes of all real activity related variables, but net stock issuance from year 1 to year 4, with the exception of net stock issuance where the effect disappears after one year. On average, firms affected by short-sell reports significantly invest less and issue less stock even four years after the publication of the report.

[Insert Figure 7 about here]

4.3 Additional Tests

In this Section, we provide more evidence to corroborate our conjecture that the short-seller research drives the changes of real activities of target firms. While the results presented in Table 4 and 5 indicate that target firms issue less stocks and reduce their investments upon the short-seller research, the concern still exists that short-sellers do not randomly select firms to write report on. That says, the firms who are targeted by the short seller attention are experiencing some problems, which cause their outcomes to slide down. In this case, the target firms would issue less stocks and reduce investments regardless of the short-sellers' research reports. To address this concern, we conduct three tests as detailed below.

4.3.1 Short-seller research and I/B/E/S Guidance

In the first test, we examine whether managers of target firms are looking down their future earnings and sales. In doing so, we are able to check whether target firms tend to have less investments and growth regardless of the short-sellers' research reports. We obtain the sales and earnings forecasts data from the I/B/E/S Guidance database, which compares manager forecasts with analysts consensus forecasts. If the forecast of a firm's manager beats (shortfalls) the consensus, I/B/E/S assigns a value of 2 (1) for this firm's guidance code. If the forecast matches the consensus, the value of guidance code is 3. To facilitate our test, we change the value of guidance code to 2 if the manager forecast matches the consensus and to 3 if the forecast beats the consensus. As such, a higher value of guidance code implies that managers tend to make optimistic forecasts relative to analysts'.

Having obtained the I/B/E/S guidance data, we then run the OLS panel regression of guidance code for earnings and sales forecasts on a dummy variable $D_{i,t}$ that takes one if firms are targeted by short-seller research in the next year,

$$Guidance\_code_{i,t} = \beta_1 D_{i,t} + Year_t + Firm_i + Control_{i,t} + \epsilon_{i,t}, \tag{3}$$

where $Year_t$ and $Firm_i$ denote time and firm fixed effects, respectively. A negative coefficient estimation on $D_{1,i,t}$ implies that managers are pessimistic about their future earnings and sales. Table 6 reports the regression results with controlling variables including firm log of size, log of book-to-market ratio, profitability, investment-to-asset, and past one-year return. We find that the coefficient on the dummy is not significant. Therefore, there is no evidence indicating that managers are looking down their future earnings and sales prior to the publications of the short-seller research. In this case, it is unlikely that the downward change in investment and stock issuance is a coincidence with short-seller research.

[Insert Table 6 about here]

4.3.2 Downward price correction and real activity

In the second test, we study whether target firms who experienced more downward price correction induced by the short-sellers' research reports have less stock issuance and investment. After all, the downward price correction would have an important feedback effect on real activities (van Binsbergen and Opp (2019)). To examine this, we look at the relation between cumulative alpha of target firms upon the publication of short-seller research and the change in real activities. We use the six-month cumulative alpha since the subsequent price revisions equal -20% and take up to 6 months to materialize, a finding that we have presented in the previous Section. We break the target firms into two groups where the break point is the median value of their cumulative alphas, which is -11%. By sort firm on the cumulative alpha, we are able to differentiate the change in real activities between groups with more downward price correction and groups with less price correction,

Since our return horizon is six months immediately after the report publications, we look at how real activities change in one year after the publication date. The resulting OLS panel regression of real activities is,

$$Real\_activity_{i,t} = \beta_1 D_{1,i,t} + \beta_2 D_{2,i,t} + \beta_3 D_{3,i,t} + \beta_4 D_{4,i,t} + Year_t + Firm_i + \epsilon_{i,t}, \quad (4)$$

where $Year_t$ and $Firm_i$ denote time and firm fixed effects, respectively. $D_{1,i,t}$ and $D_{2,i,t}$ are two dummy variables that take the value of one if a firm has a short-sale report written about them in the past twelve months and its cumulative alpha is above and below the median, respectively.

[Insert Table 7 about here]

Table 7 reports the regression results with control variables considered in Table 5. When using net stock issuances as the dependent variable, the coefficient estimations are almost identical in terms of both significance and magnitude. However, when testing the investment, we find that the coefficient estimations on $D_{2,i,t}$ are more significantly negative and larger in

the magnitude than the estimations on $D_{1,i,t}$. For example, when using investment-to-asset as the dependent variable, the coefficient estimations on $D_{2,i,t}$ and on $D_{1,i,t}$ are -0.255 (t-statistic is -4.854) and -0.255 (t-statistic is -2.188), respectively. Therefore, firms with larger negative alphas have 10% less investment-to-asset than firms with smaller negative alphas. The findings imply that the downward price correction induced by short-seller research plays an important role in driving target firms' investment.

4.3.3 Accounting fraud and real activity

In the final test, we examine whether firms with accounting frauds that have not been identified by short-seller research would not issue less stocks and reduce investments. That says, only the firms whose accounting frauds are mentioned by short-seller research experience downward change in real activities. We use the accounting fraud as an instrument here because most of the target firms have accounting frauds identified by short-sellers, as shown by our textual analysis. If it is the short-seller research that drives the downturn in the target firms' real activities, then we should expect that firms with accounting frauds that have not been identified by short-seller research will not have any changes for their real activities.

To test this, we obtain accounting fraud data from Audit Analytics' (AA) earnings restatement database for the period between 2007 and 2020. AA earnings restatement database assigns a dummy variable "RES_FRAUD" that takes one for the public firms who have accounting frauds reported by SEC. One issue here is that there is overlap between the accounting-fraud firms mentioned in short-seller research reports and those identified by SEC. There, we exclude the overlapped ones when testing the accounting fraud identified by SEC.[14]

Having obtained the accounting fraud data, we then run the panel OLS regressions of changes in real activities on four dummy variables that take one if firms are listed in the short-seller research reports in the past one ($DS_{1,i,t}$), two ($DS_{2,i,t}$), three ($DS_{3,i,t}$), and four

[14]Using Audit Analytics' (AA) earnings restatement database, we obtain 138 firms with accounting fraud for the period between 2007 and 2020. We then match PERMNO to these firms using the CIK identifier ("COMPANY_FKEY"), and we have 85 observations left at firm-year level. Among these 85 firms, three of them are also mentioned in short-seller research reports. Therefore, we exclude the three firms and have 82 observations left at firm-year level for accounting fraud.

years ($DS_{4,i,t}$), respectively, and on another four dummies if firms have accounting fraud but are not listed in the short-seller research reports in the past one ($DF_{1,i,t}$), two ($DF_{2,i,t}$), three ($DF_{3,i,t}$), and four years ($DF_{4,i,t}$), respectively,

$$\begin{aligned} Real\_activity_{i,t} = \beta_1 DS_{1,i,t} + \beta_2 DS_{2,i,t} + \beta_3 DS_{3,i,t} + \beta_4 DS_{4,i,t} + \beta_5 DF_{1,i,t} + \beta_6 DF_{2,i,t} \\ + \beta_7 DF_{3,i,t} + \beta_8 DF_{4,i,t} + \gamma Control_{i,t} + Year_t + Firm_i + \epsilon_{i,t} \end{aligned} \tag{5}$$

where $Year_t$ and $Firm_i$ denote time and firm fixed effects, respectively.

[Insert Table 8 about here]

Table 8 reports the regression results with control variables considered in Table 5. Consistent with our findings in Table 5, we find that firms who are the targets of short-seller research issue less stocks and reduce investment and the effect remains significant even after four years of the publication of research reports. In sharp contrast, none of the coefficients on the dummies that represent firms with accounting fraud are significantly negative. Therefore, only the firms whose accounting frauds are mentioned by short-seller research experience downward change in real activities. As such, short-seller research is an important factor contributing to target firms' changes in real activities.

5 Short-sale Volume and Investor Attention

If the release of the research reports drives the real and financial activity, there must be evidence of investors paying attention to them. In particular, suppose investor attention increases after the release of negative cash-flow news by the reports. In that case, this attention should result in higher short-sell and trading volumes that cause selling pressures on these stocks and downward prices corrections. After the downward price revision, the cost of capital is higher for the firms, which leads to fewer investments. Furthermore, the lower market capitalization makes it less attractive to issue stocks.

To corroborate the assumption, we provide evidence of a substantial increase in investor

attention. We consider both market measures of attention, such as trading volume and daily returns (see Barber and Odean (2008) and Da et al. (2011)), as well as direct measures of information demand the number of downloads of 10-K reports (Ryans (2017)).

We first look at the short-sale trading volume. Following Wang et al. (2020), we obtain daily aggregate short-sale volume at the individual stock level from Financial Industry Regulatory Authority (FINRA). The daily aggregate short-sale volume is defined as the total short-sale volume divided by the total trading volume reported to FIRNA.

Figure 8 plots the average of the daily share-sale trading volume for the target firms who are mentioned in short-seller research reports. Consistent with our conjecture, we find that the share-sale trading volume on the event day is around 10% higher than usual.

[Insert Figure 8 about here]

While short-sale trading can cause downward price corrections, the selling pressure from investors' trades can also contribute to the price declines. To study whether tradings increase substantially on the event day, we obtain daily volume data at individual security level from The Center for Research in Security Prices (CRSP). We then measure share turnover as volume divided by total shares outstanding. Figure 9 plots the average of the share turnover for the target firms in the short-sellers research reports. Consistent with our conjecture, the turnover increases to approximately 6% on the day of the publication date, compared to an average value of 2%. Interestingly, we observe an increase in trading before the report's publication date, consistent with either information leakage or the short seller firms timing the information release to benefit from short positions.

[Insert Figure 9 about here]

Further, we compare the attention of short-seller target firms to other firms on the publication day of research reports by running panel OLS regressions of proxies of investor attention:

$$Investor\_attention_{i,t} = \beta Dummy_{i,t} + \gamma Control_{i,t} + Firm_i + Year_t + \epsilon_{i,t}$$

where $Dummy_{i,t}$ is a dummy variable that takes the value of one if a short-seller research report targeting firm i is released on the trading day t and is zero otherwise. $Firm_i$ and $Year_t$ indicate firm and year fixed effects. In addition to share turnover and short-sale volume ratio, we also use daily returns and the daily number of downloads of 10-K reports (firm annual reports) as proxies for investor attention. Barber and Odean (2008) argue that extreme daily returns are likely to be associated with attention-grabbing events and therefore can be used as a proxy for investor attention. The U.S. EDGAR log file data set from the Securities and Exchange Commission is a collection of web server log files where researchers can study the demand for SEC filings (Ryans (2017)). Therefore, the firms' 10-K downloads are indicative of investors' attention to this firm.[15]

Table 9 reports the univariate panel OLS regressions of proxies of investor attention on the dummy variable. We find that the coefficient estimates on share turnover, 10-K downloads, and short-sale volume ratio are significantly positive, indicating that the target firms receive more attention than other firms upon the publications of research reports. On average, short-sale firms have a 0.042 higher turnover rate, around 64 more 10-k report downloads, and 0.039 higher short-sale volume ratio. Moreover, the coefficient estimate on daily return is -0.044, which is significantly negative (t-statistic is -8.848). Therefore, short-sale firms earn lower returns than other firms on the event day, consistent with our previous findings that the research reports cause a downward price correction on target firms' stock prices.

[Insert Table 9 about here]

Table 10 reports the multivariate panel OLS regressions with control variables, including the log of firm size, log of book-to-market ratio, gross profitability-to-asset, and investment-to-assets. The findings presented in the univariate regression remain significant after includ-

[15] We are grateful to James Ryans' for allowing for the download of the data, available at his website: http://www.jamesryans.com

ing control variables.

[Insert Table 10 about here]

6 Analysts and Short-seller Research

Analysts play an important role in the financial markets by making buy recommendations, price targets, and earnings forecasts (Engelberg et al. (2020) and van Binsbergen et al. (2020)). Analysts' predictions can be decomposed to public and private signals.[16] Since the short-sellers' research reports are public signals related to firms' stock prices, analysts may also react to these reports by making changes in their recommendations and price targets.

To study whether analysts make responses, we use the analysts consensus recommendation and price target data available at /I/B/E/S. /I/B/E/S assigns a numeric value, which ranges from 1 to 5, to calculate analysts' consensus recommendation, namely the rating for a particular company. A value of 1 indicates a strong buy, whereas 5 indicates strong sell. Further, analysts also provide price targets at a 12-month horizon. Both data are at monthly frequency in the sense that analyst update their recommendations and price targets monthly.

Each month we take the average of analysts' recommendation score for firms who are subject to short-seller research reports. Since analysts' price targets are different across firms in that some firms have very large target prices while others have small, we use the changes in analysts' price targets, defined as the log difference in price targets between this month and the last month. To study the dynamic changes in analysts' recommendations and price targets, we consider a 24-month window in which month 0 is the month when research reports are published. We also consider the year prior to the publication date since the downward change in analysts' forecasts might cause the presence of the short-seller research reports.

Figure 10 plots the average of analysts' recommendation score in a 24-month window. While we find evidence that the analysts recommendation score increases after the event month, there is a upward trend already prior to the event month. Moreover, the increase

[16] see Hughes et al. (2008) and van Binsbergen et al. (2020) among others.

is economically small, from around 2.07 in event month to 2.17 in month 6. Therefore, the findings presented in Figure 10 do not demonstrate that analysts respond to the short-seller research reports by recommending to strongly sell the stocks of the target firms.

[Insert Figure 10 about here]

Figure 11 plots the average of changes in analysts' price targets. We find that the changes in analysts' price targets are on average positive before the event month. A negative change, namely downward revision, only appears after the event month. The downward revision in analysts' price targets reaches to its highest point at around -1.5% in month 6, consistent with horizon of downward revision in market price shown by Figure 3. In the subsequent month after month 6, the revision however, becomes positive. Overall, these findings suggest that analysts react to the negative news in the reports by making downward revision in price targets.

[Insert Figure 11 about here]

However, one concern related to the results presented above is that analysts can also make downward revisions for firms who are not subject to short-seller research reports. That says, the downward revision is at the aggregate market level rather than firm-specific. In response to this concern, we run a panel OLS regressions of changes in analysts' consensus recommendation and price targets on the dummy variable that takes one if firms have short-sale reports on a trading day. For robustness check, we also consider the changes in median of analysts' recommendation and price targets.[17]

Table 11 presents the results of the univariate regressions. We find that when the dependent variable is the change in price targets, the coefficient estimation on the dummy variable is significantly negative. Therefore, firms who are subject to short-seller research reports experience downward revisions in price targets relative to other firms. When the change in recommendations is used as a dependent variable, the coefficient estimation the dummy is

[17]Each month, we winsorize changes in analysts' consensus recommendation and price targets at 1%.

not significantly negative, consistent with the findings shown in Figure 10.

[Insert Table 11 about here]

Table 12 reports the multivariate panel OLS regressions with control variables including log of firm size, log of book-to-market ratio, gross profitability-to-asset, and investment-to-assets. The findings presented in the univariate regression remain consistent after considering control variables.

[Insert Table 12 about here]

7 Conclusion

In this paper we investigate stock price movements and changes in real investment associated with short-sell research. We construct and make publicly available a comprehensive database of short-sell research reports and find that many of them relate to exposing accounting fraud or other financial misconduct. We argue that investors pay attention to these reports as various attention measures spike around their publication date.

We further document significant increases in volatility and significant decreases in returns on the publication day of the report. The abnormal return equals -4% on the publication day itself and continues for up to 6 months with a cumulative total effect of -24%. On average, each report results in a change in market value equal to \$1 billion, and analysts react by changing their price targets.

Most importantly, we have demonstrated in this paper that short-sell research and their subsequent stock-market reaction are associated with large real economic consequences. Companies reduce their capital and R&D expenditure by up to 2% of assets, which translates into an average value of \$118 million in corporate investment per report. In addition, firms mentioned in the reports respond to the downward price correction by significantly reducing net stock issuances equal to \$179 million on average.

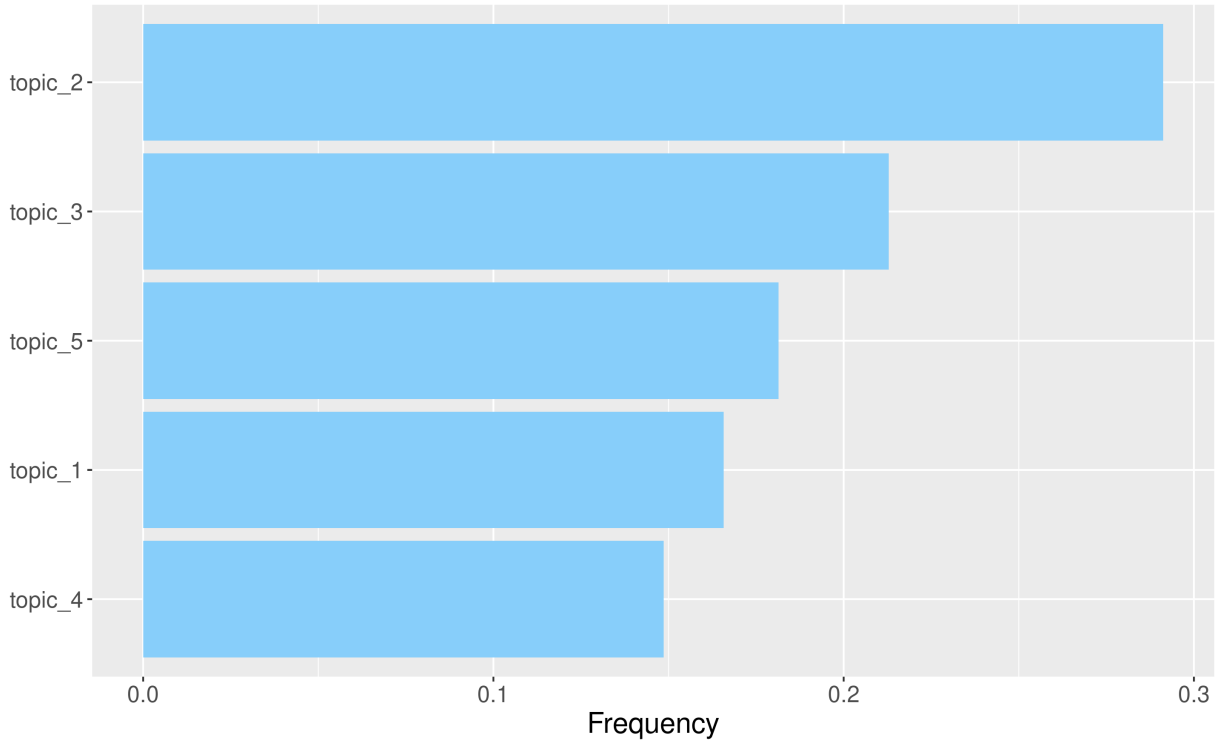
We conclude that short-sell research not only affects financial market outcomes but also has a significant effect on real economic allocations.

Figures and Tables

Figure 1: Word Cloud of Topics

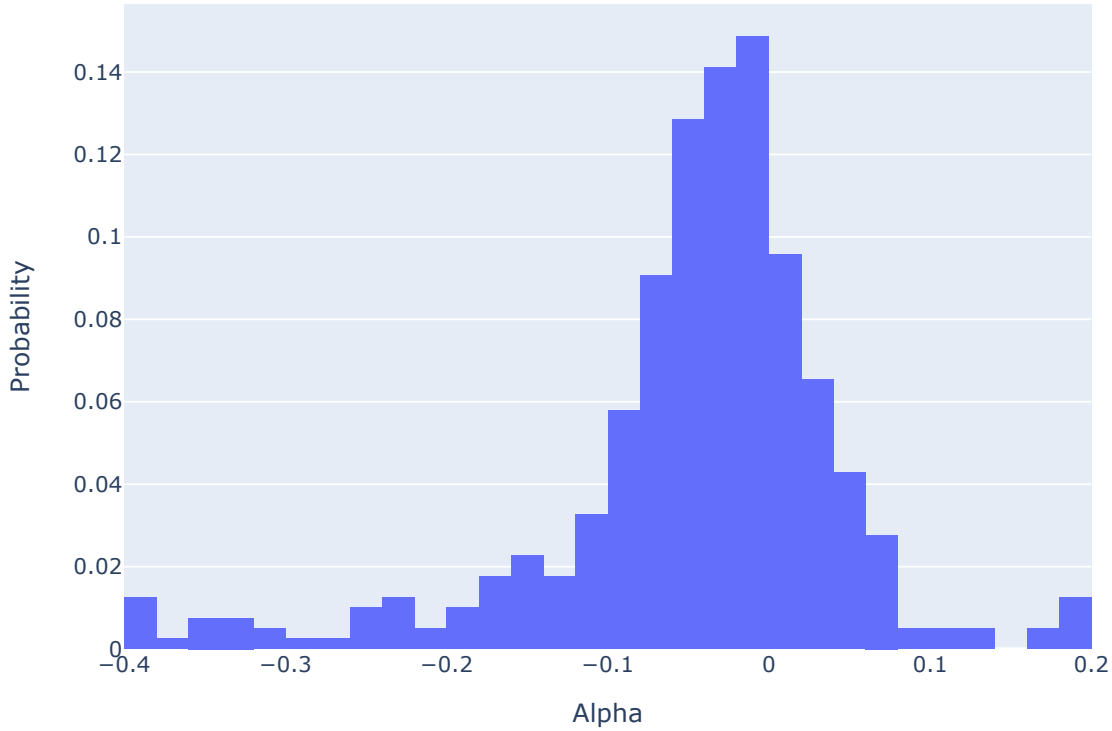
This figure plots the result of running LDA with five topics. Each cluster of words corresponds to each topic. Bigger words correspond to a higher than average probability of occurring within that topic.

Figure 2: Frequency of Topics



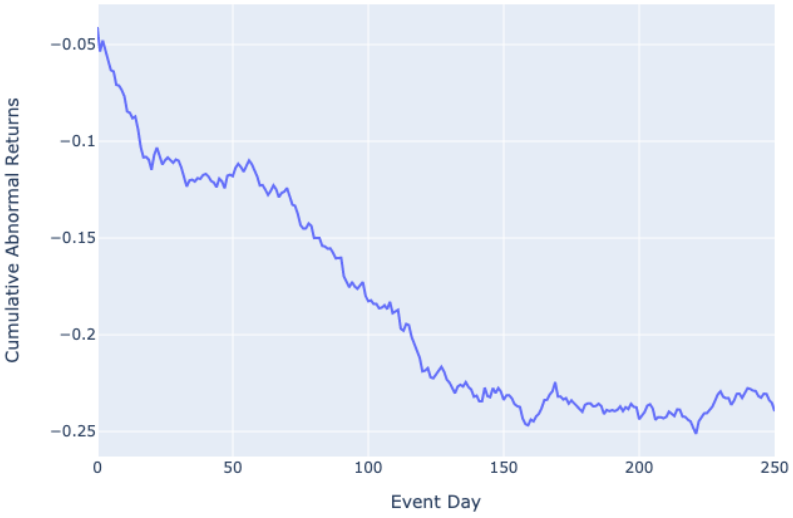
This figure plots the frequency of each topic. The frequency corresponds to the average percentage of the report that firms allocate to each topic.

Figure 3: Distribution of abnormal returns on the publication day

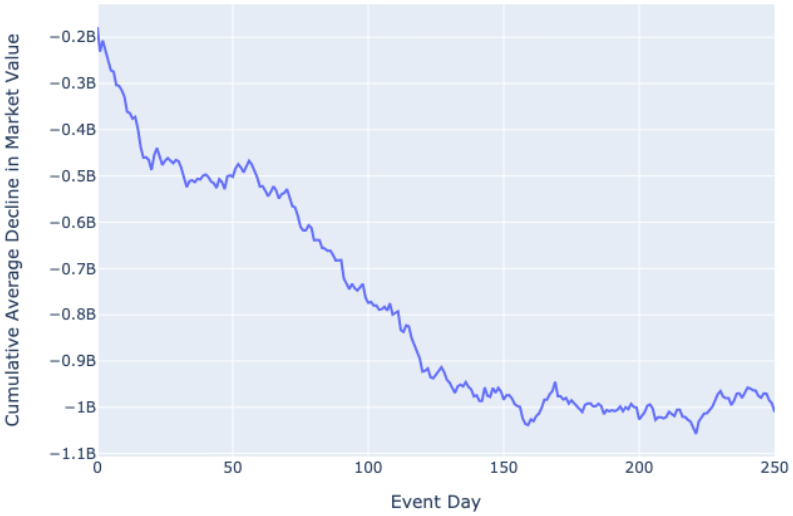


This figure plots the distribution of abnormal returns of target firms on the day when short-seller research reports are public available.

Figure 4: Cumulative abnormal return and decline in market value



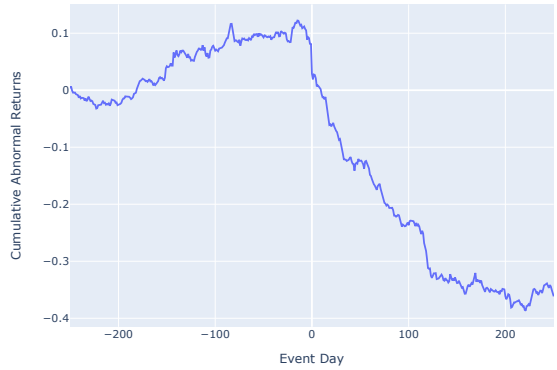
(a) Cumulative abnormal return



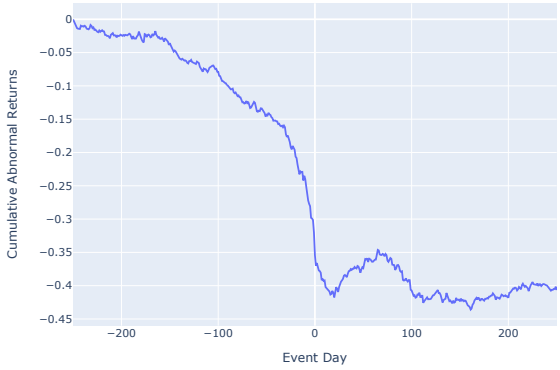
(b) Cumulative decline in market value

This figure plots (a) the value-weighted average of cumulative abnormal returns and (b) the cumulative decline in market value (in billion) of target firms in a window of 250 trading days. Event day 0 is the publication day of short-seller research reports.

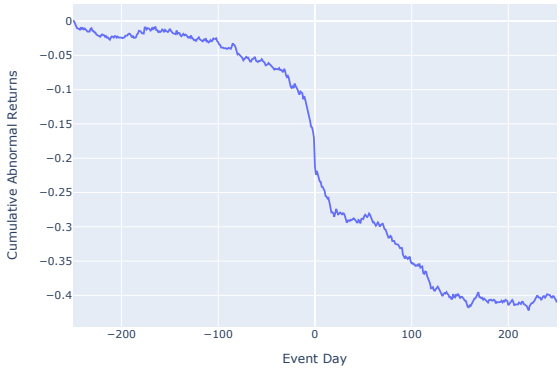
Figure 5: Positive VS. Negative past returns



(a) Positive Past Returns



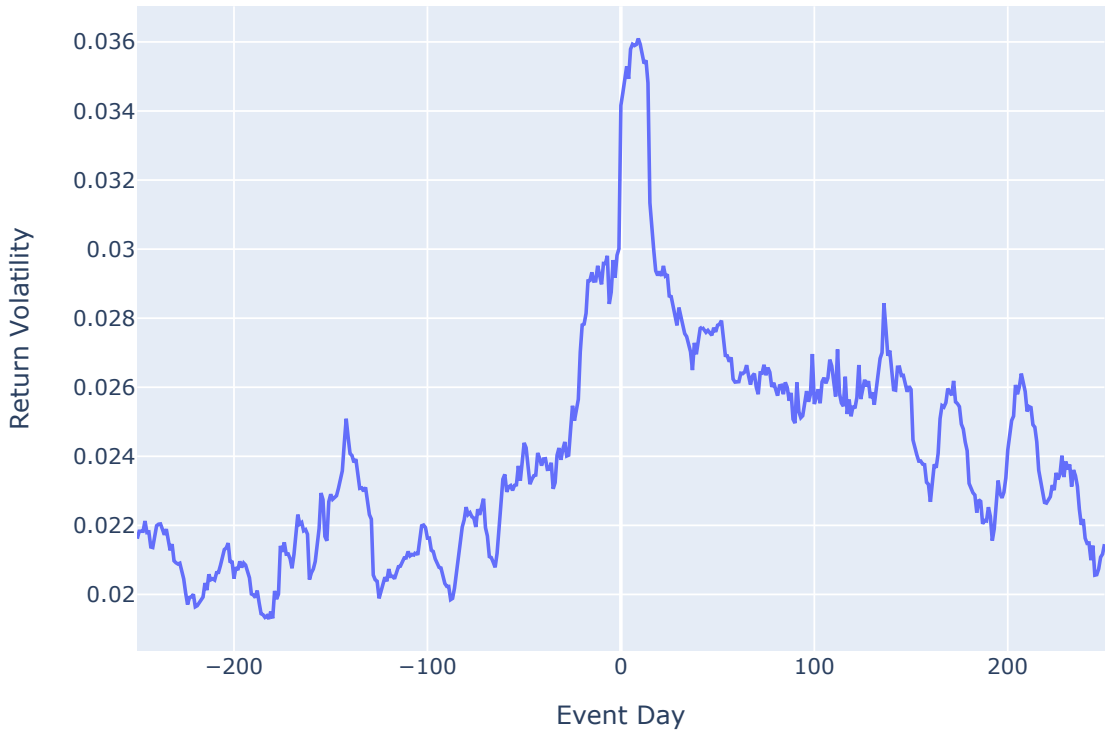
(b) Negative Past Returns



(c) All

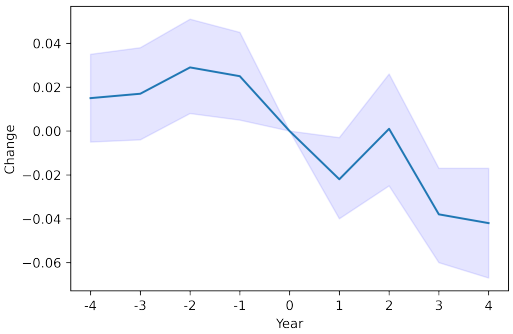
Figure (a) and (b) plot the value-weighted average of cumulative abnormal returns of target firms whose cumulative abnormal returns before publication day are positive and negative, respectively. Figure (c) looks at all target firms. Event day 0 is the publication day of short-seller research reports.

Figure 6: Return Volatility

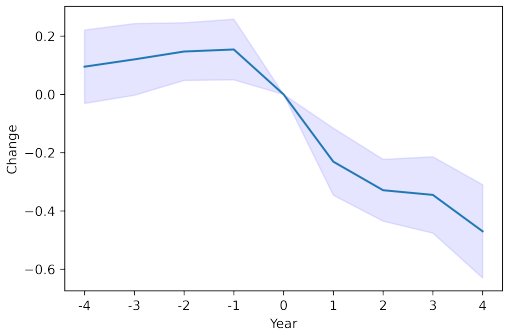


This figure plots the value-weighted average of return volatility of target firms in a window of 500 trading days. Event day 0 is the publication day of short-seller research reports.

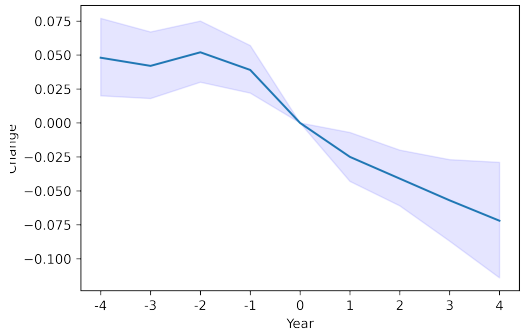
Figure 7: Time-varying changes in real activities



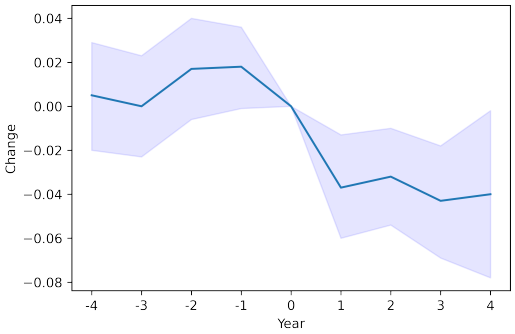
(a) Net Stock Issuance



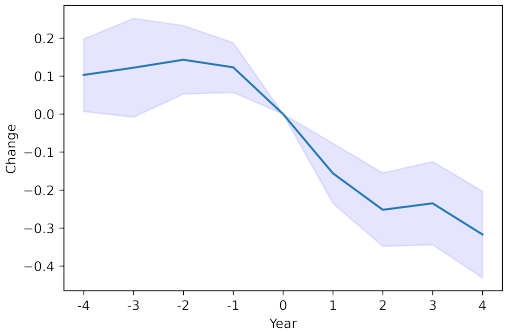
(b) Investment-to-Asset



(c) Capital and R&D Expenditure



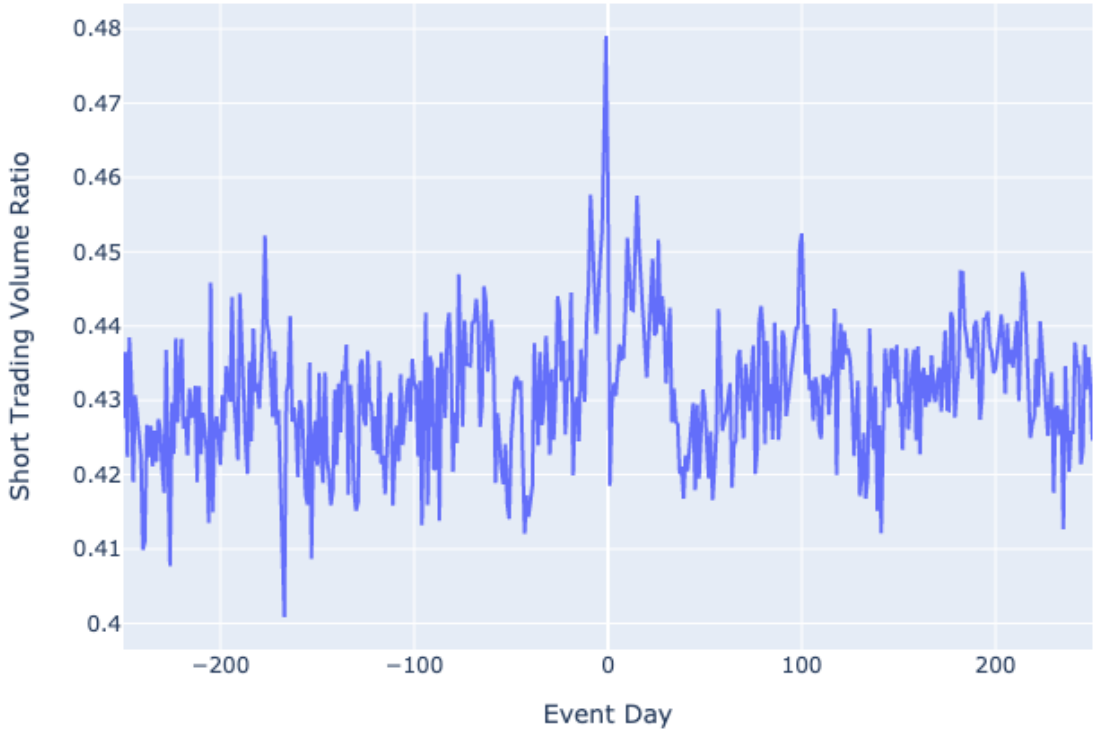
(d) Changes in PPE and Inventory



(e) Sale Growth

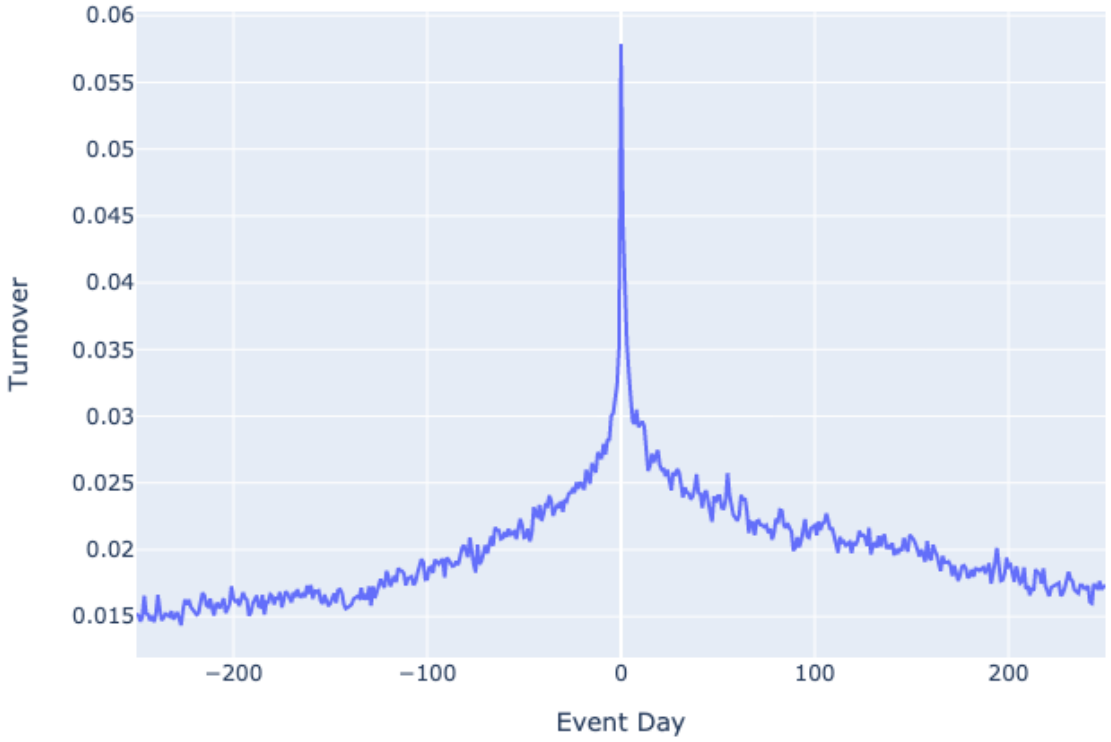
This figure plots the time-varying changes in target firms' real activities in a window of eight years. Year 0 is the year when short-seller research reports are published. The changes in real activities in each year t are measured as the differences between real activities in year t and real activities in year 0.

Figure 8: Share-sale trading volume



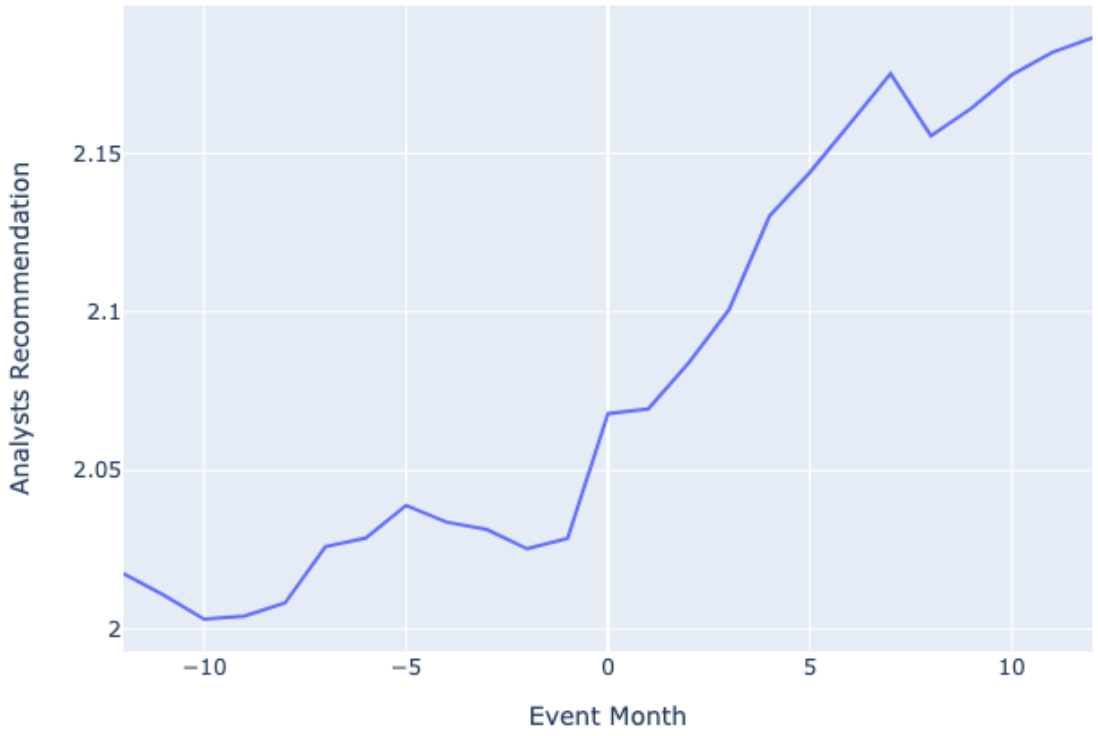
This figure plots the average of daily short-sale trading volume of target firms in a window of 500 trading days. Event day 0 is the publication day of short-seller research reports.

Figure 9: Share turnover



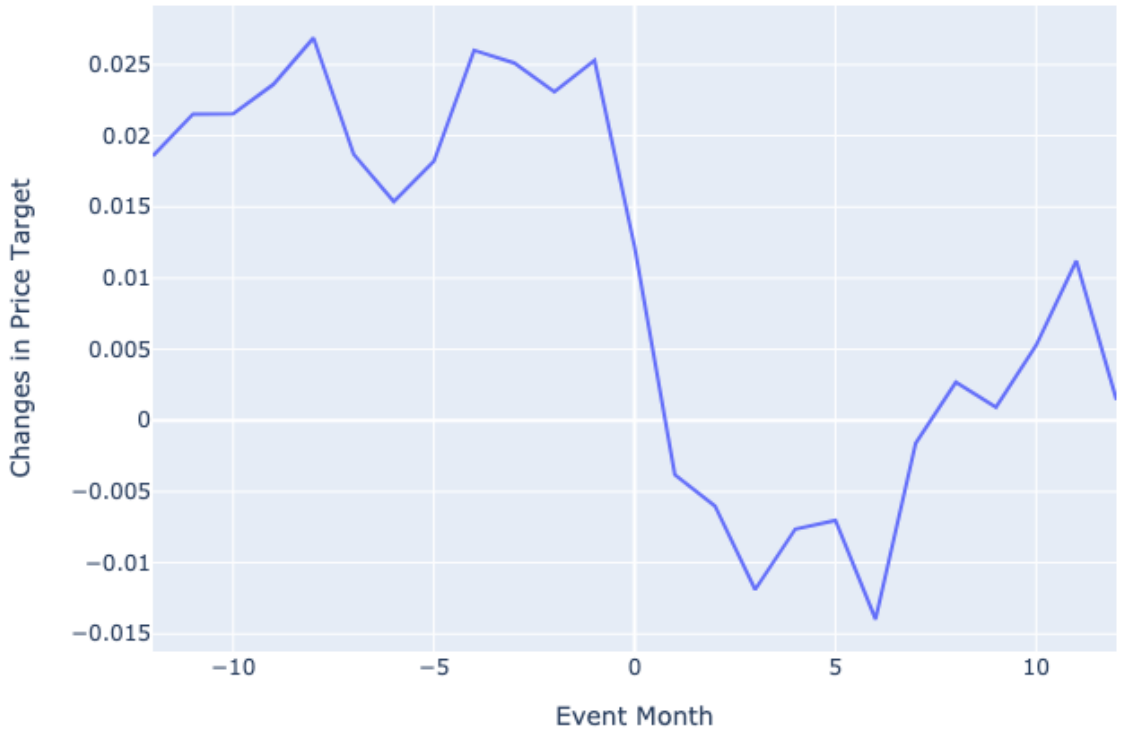
This figure plots the average of daily share turnover of target firms in a window of 500 trading days. Event day 0 is the publication day of short-seller research reports.

Figure 10: Analysts' sell recommendations



This figure plots the average of analysts' sell recommendation for target firms in a window of 24 months. Month 0 is the month when short-seller research reports are public available. A higher number indicates a stronger recommendation to sell.

Figure 11: Changes in analysts' price target



This figure plots the average of changes in analysts' price targets for target firms in a window of 24 months. Month 0 is the month when short-seller research reports are public available.

Table 1: Firm Types

This table presents the summary statistics of the differences between the characteristics of frims who are subject to short-seller research reports and the cross-sectional mean/median of other firms'.

Variable	Mean	Std	P5	P10	Q1	Median	Q3	P90	P95	N	t-stat
Panel A: Comparison to the mean											
Age	-77.444	145.475	-200.833	-194.115	-178.059	-133.685	-10.235	87.138	212.657	320.0	-9.523
Size	0.812	1.521	-1.665	-1.088	-0.252	0.690	1.853	2.877	3.494	318.0	9.516
NSI	0.019	0.155	-0.112	-0.092	-0.062	-0.041	0.051	0.199	0.320	258.0	1.997
GP	0.118	0.283	-0.208	-0.163	-0.060	0.058	0.228	0.524	0.749	286.0	7.019
BM	-0.681	0.986	-2.343	-2.008	-1.321	-0.611	-0.047	0.395	0.818	273.0	-11.423
IA	0.340	0.850	-0.305	-0.251	-0.116	0.086	0.454	1.144	1.875	276.0	6.633
CAP_RD	0.003	0.183	-0.166	-0.150	-0.108	-0.058	0.042	0.228	0.358	187.0	0.197
PIA	0.053	0.153	-0.078	-0.056	-0.034	-0.005	0.080	0.241	0.363	265.0	5.595
SG	0.270	0.560	-0.276	-0.191	-0.047	0.103	0.432	0.991	1.220	266.0	7.866
Panel B: Comparison to the median											
Age	-32.474	146.168	-156.000	-151.000	-134.250	-87.500	35.000	128.500	262.000	320.0	-3.974
Size	0.897	1.514	-1.543	-1.001	-0.120	0.789	1.932	2.941	3.577	318.0	10.558
NSI	0.076	0.157	-0.066	-0.030	-0.004	0.016	0.106	0.264	0.380	258.0	7.811
GP	0.151	0.283	-0.176	-0.131	-0.031	0.095	0.262	0.562	0.784	286.0	9.018
BM	-0.716	0.984	-2.399	-2.039	-1.355	-0.642	-0.081	0.352	0.765	273.0	-12.035
IA	0.467	0.853	-0.170	-0.094	0.015	0.195	0.578	1.250	1.965	276.0	9.088
CAP_RD	0.087	0.186	-0.075	-0.060	-0.034	0.028	0.139	0.308	0.464	187.0	6.379
PIA	0.081	0.154	-0.042	-0.031	-0.006	0.022	0.109	0.274	0.385	265.0	8.558
SG	0.360	0.558	-0.195	-0.085	0.035	0.195	0.515	1.071	1.306	266.0	10.530

Table 2: Alphas on the report publication day

This table presents the summary statistics of abnormal returns of target firms on the day when the short-seller research reports are made public available.

Summary	Mean	Std	P5	P10	Q1	Median	Q3	P90	P95	t-stat
Alpha	-0.045	0.11	-0.242	-0.157	-0.074	-0.031	0.002	0.045	0.067	-8.206

Table 3: Change of firms' real economy activities

This table presents the changes of target firms' real economy activities after the publications of short-seller research reports. The changes in real activities are measured as the differences between real activities in the year t+1 and real activities in the year t, when short-seller research reports are public available.

Variable	Mean	Std	P5	P10	Q1	Median	Q3	P90	P95	N	t-statistic
NSI	-0.022	0.144	-0.318	-0.130	-0.039	-0.002	0.019	0.083	0.133	226.0	-2.265
GP	-0.012	0.099	-0.156	-0.114	-0.051	-0.004	0.031	0.086	0.119	238.0	-1.825
LNbeme	0.171	0.711	-0.914	-0.579	-0.226	0.066	0.490	1.121	1.528	215.0	3.518
IA	-0.231	0.901	-1.818	-0.967	-0.444	-0.102	0.066	0.288	0.563	237.0	-3.949
CAP_RD	-0.025	0.116	-0.205	-0.131	-0.049	-0.007	0.010	0.068	0.136	162.0	-2.770
PIA	-0.037	0.183	-0.423	-0.211	-0.068	-0.008	0.024	0.109	0.204	228.0	-3.026
SG	-0.156	0.616	-1.045	-0.803	-0.252	-0.078	0.042	0.220	0.643	233.0	-3.865

Table 4: Univariate tests of real activities

This table reports the panel OLS regressions of changes in real activities on four dummy variables that take one if firms are listed in the short-seller research reports in the past one ($D_{1,i,t}$), two ($D_{2,i,t}$), three ($D_{3,i,t}$), and four years ($D_{4,i,t}$), respectively. $Year_t$ and $Firm_i$ denote time and firm fixed effects, respectively. t-statistic are measured based on the standard errors clustered at the firm and year level.

$$Real\_activity_{i,t} = \beta_1 D_{1,i,t} + \beta_2 D_{2,i,t} + \beta_3 D_{3,i,t} + \beta_4 D_{4,i,t} + Year_t + Firm_i + \epsilon_{i,t}$$

	NSI	IA	PIA	SG	CAP_RD
D_1	-0.018	-0.133	-0.005	-0.055	-0.026
	(-2.343)	(-3.189)	(-0.487)	(-1.177)	(-3.083)
D_2	0.022	-0.188	0.001	-0.12	-0.024
	(1.104)	(-5.0)	(0.076)	(-2.609)	(-2.031)
D_3	-0.003	-0.157	-0.009	-0.074	-0.029
	(-0.174)	(-4.83)	(-1.945)	(-1.107)	(-2.809)
D_4	-0.018	-0.208	0.009	-0.155	-0.034
	(-2.336)	(-6.514)	(0.72)	(-5.569)	(-2.922)
Adj R-sqr(%)	-0.002	0.058	-0.004	0.03	0.029
N	91332.0	69536.0	58421.0	66773.0	36126.0
Firm Fixed Effect	YES	YES	YES	YES	YES
Time Fixed Effect	YES	YES	YES	YES	YES

Table 5: Multivariate tests of real activities

This table reports the panel OLS regressions of changes in real activities on four dummy variables that take one if firms are listed in the short-seller research reports in the past one ($D_{1,i,t}$), two ($D_{2,i,t}$), three ($D_{3,i,t}$), and four years ($D_{4,i,t}$), respectively. $Year_t$ and $Firm_i$ denote time and firm fixed effects, respectively. t-statistic are measured based on the standard errors clustered at the firm and year level.

$$Real\_activity_{i,t} = \beta_1 D_{1,i,t} + \beta_2 D_{2,i,t} + \beta_3 D_{3,i,t} + \beta_4 D_{4,i,t} + \beta_5 ShortInt_{i,t} + \beta_6 LNsize_{i,t} + \beta_7 LNat_{i,t} + Year_t + Firm_i + \epsilon_{i,t}$$

	NSI	IA	PIA	SG	CAP_RD
D_1	-0.035	-0.252	-0.025	-0.118	-0.02
	(-4.434)	(-5.923)	(-2.499)	(-2.519)	(-2.317)
D_2	-0.006	-0.296	-0.016	-0.172	-0.017
	(-0.655)	(-7.576)	(-2.302)	(-3.676)	(-1.569)
D_3	-0.032	-0.246	-0.021	-0.097	-0.018
	(-4.375)	(-6.308)	(-3.143)	(-1.451)	(-1.689)
D_4	-0.031	-0.229	0.003	-0.157	-0.018
	(-4.789)	(-10.958)	(0.264)	(-6.486)	(-1.982)
ShortInt	-0.038	-0.474	-0.064	0.02	-0.152
	(-0.534)	(-1.972)	(-2.854)	(0.236)	(-2.696)
LNsize	0.007	0.112	0.029	0.106	0.03
	(1.493)	(9.128)	(6.977)	(9.038)	(10.796)
LNat	-0.0	0.18	0.025	0.017	-0.039
	(-0.066)	(4.282)	(4.58)	(0.898)	(-8.303)
Adj R-sqr(%)	0.055	5.068	4.363	2.139	1.933
N	65276.0	67697.0	56837.0	65009.0	35117.0
Firm Fixed Effect	YES	YES	YES	YES	YES
Time Fixed Effect	YES	YES	YES	YES	YES

Table 6: Multivariate tests of real activities

This table reports the panel OLS regressions of changes in real activities on an dummy variable ($D_{i,t}$) that takes one if firms are targeted by short-seller research in the next year. $Year_t$ and $Firm_i$ denote time and firm fixed effects, respectively. t-statistic are measured based on the standard errors clustered at the firm and year level.

$$Guidance\_code_{i,t} = \beta_1 D_{i,t} + Year_t + Firm_i + Control_{i,t} + \epsilon_{i,t},$$

	Earnings	Sales
D	0.029	0.005
	(0.268)	(0.078)
Adj R-sqr(%)	0.697	0.29
N	11119.0	12891.0
Firm Fixed Effect	YES	YES
Time Fixed Effect	YES	YES
Control Variable	YES	YES

Table 7: Univariate tests of real activities

This table reports the panel OLS regressions of changes in real activities on two dummy variables: $D_{1,i,t}$ and $D_{2,i,t}$ that take the value of one if a firm has a short-sale report written about them in the past twelve months and its cumulative alpha is above and below the median, respectively. t-statistic are measured based on the standard errors clustered at the firm and year level.

$$Real\_activity_{i,t} = \beta_1 D_{1,i,t} + \beta_2 D_{2,i,t} + Year_t + Firm_i + \epsilon_{i,t}$$

	NSI	IA	PIA	SG	CAP_RD
D_1	-0.031	-0.155	-0.016	-0.093	-0.017
	(-2.567)	(-2.188)	(-0.787)	(-1.272)	(-1.508)
D_2	-0.03	-0.255	-0.02	-0.131	-0.011
	(-2.072)	(-4.854)	(-2.17)	(-2.206)	(-1.488)
Adj R-sqr(%)	0.046	4.957	4.347	2.093	1.92
N	65276.0	67697.0	56837.0	65009.0	35117.0
Firm Fixed Effect	YES	YES	YES	YES	YES
Time Fixed Effect	YES	YES	YES	YES	YES
Control Variables	YES	YES	YES	YES	YES

Table 8: Multivariate tests of real activities

This table reports the panel OLS regressions of changes in real activities on four dummy variables that take one if firms are listed in the short-seller research reports in the past one ($DS_{1,i,t}$), two ($DS_{2,i,t}$), three ($DS_{3,i,t}$), and four years ($DS_{4,i,t}$), respectively, and on another four dummies if firms have accounting fraud but are not listed in the short-seller research reports in the past one ($DF_{1,i,t}$), two ($DF_{2,i,t}$), three ($DF_{3,i,t}$), and four years ($DF_{4,i,t}$), respectively, and on another four dummies if . $Year_t$ and $Firm_i$ denote time and firm fixed effects, respectively. t-statistic are measured based on the standard errors clustered at the firm and year level.

$$Real\_activity_{i,t} = \beta_1 DS_{1,i,t} + \beta_2 DS_{2,i,t} + \beta_3 DS_{3,i,t} + \beta_4 DS_{4,i,t} + \beta_5 DF_{1,i,t} + \beta_6 DF_{2,i,t} + \beta_7 DF_{3,i,t} + \beta_8 DF_{4,i,t} + \gamma Control_{i,t} + Year_t + Firm_i + \epsilon_{i,t}$$

	NSI	IA	PIA	SG	CAP_RD
DS_1	-0.035	-0.252	-0.025	-0.118	-0.02
	(-4.354)	(-5.916)	(-2.469)	(-2.516)	(-2.314)
DS_2	-0.005	-0.296	-0.016	-0.172	-0.017
	(-0.606)	(-7.618)	(-2.315)	(-3.697)	(-1.577)
DS_3	-0.032	-0.246	-0.021	-0.096	-0.018
	(-4.295)	(-6.265)	(-3.187)	(-1.447)	(-1.69)
DS_4	-0.031	-0.229	0.003	-0.155	-0.018
	(-4.921)	(-11.036)	(0.249)	(-6.787)	(-1.988)
DF_1	-0.007	-0.014	0.014	-0.044	-0.011
	(-0.289)	(-0.178)	(0.64)	(-0.649)	(-0.579)
DF_2	0.044	-0.048	0.008	-0.065	-0.019
	(0.855)	(-1.165)	(0.622)	(-0.645)	(-0.921)
DF_3	-0.003	0.015	0.009	-0.059	-0.009
	(-0.142)	(0.214)	(0.952)	(-0.952)	(-0.396)
DF_4	0.003	0.014	0.008	-0.043	-0.008
	(0.101)	(0.188)	(0.389)	(-0.531)	(-0.394)
Adj R-sqr(%)	0.053	5.063	4.358	2.136	1.924
N	65276.0	67697.0	56837.0	65009.0	35117.0
Firm Fixed Effect	YES	YES	YES	YES	YES
Time Fixed Effect	YES	YES	YES	YES	YES
Control Variable	YES	YES	YES	YES	YES

Table 9: Univariate tests of investor attention proxies

This table reports the panel OLS regressions of proxies of investor attention on the dummy variable that takes one for target firms on the day when the short-seller research reports are published. Day_t and $Firm_i$ denote time and firm fixed effects, respectively. t-statistic are measured based on the standard errors clustered at the firm and day level.

$$Investor\_attention_{i,t} = \beta Dummy_{i,t} + Firm_i + Day_t + \epsilon_{i,t}$$

	TURNOVER	RET	10K-Downloading	Short_Volume_Ratio
Coeffi	0.042	-0.044	63.96	0.039
	(23.182)	(-8.848)	(6.683)	(5.233)
Adj R-sqr(%)	0.214	0.022	0.045	0.001
N	2481891.0	2481217.0	831516.0	1909665.0
Time Fixed Effect	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes
Control	No	No	No	No

Table 10: Multivariate tests of investor attention proxies

This table reports the panel OLS regressions of proxies of investor attention on the dummy variable that takes one for target firms on the day when the short-seller research reports are published. Day_t and $Firm_i$ denote time and firm fixed effects, respectively. t-statistic are measured based on the standard errors clustered at the firm and day level.

$$Investor\_attention_{i,t} = \beta Dummy_{i,t} + \gamma Control_{i,t} + Firm_i + Day_t + \epsilon_{i,t}$$

	TURNOVER	RET	10K-downloading	Short_Volume_Ratio
Coeffi	0.042	-0.04	64.835	0.041
	(23.135)	(-7.413)	(6.731)	(4.893)
Adj R-sqr(%)	0.585	0.043	0.109	0.012
N	1818498.0	1818489.0	682866.0	1502996.0
Time Fixed Effect	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes

Table 11: Univariate tests of changes in analysts' recommendation and price targets

This table reports the panel OLS regressions of changes in analysts' recommendations and price targets on the dummy variable that takes one for target firms in a month when the short-seller research reports are published. $Month_t$ and $Firm_i$ denote time and firm fixed effects, respectively. t-statistic are measured based on the standard errors clustered at the firm and month level.

$$Analysts_{i,t} = \beta Dummy_{i,t} + \gamma Control_{i,t} + Firm_i + Month_t + \epsilon_{i,t}$$

	Mean Rec	Med Rec	Mean PRC	Median PRC
Coeffi	0.003	0.0	-0.018	-0.022
	(0.531)	(0.047)	(-3.806)	(-3.783)
Adj R-sqr(%)	-0.0	-0.0	0.003	0.003
N	608003.0	608003.0	585615.0	585616.0
Time Fixed Effect	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes
Control	No	No	No	No

Table 12: Multivariate tests of changes in analysts' recommendation and price targets

This table reports the panel OLS regressions of changes in analysts' recommendation and price targets on the dummy variable that takes one for target firms in a month when the short-seller research reports are published. $Month_t$ and $Firm_i$ denote time and firm fixed effects, respectively. t-statistic are measured based on the standard errors clustered at the firm and month level.

$$Analysts_{i,t} = \beta Dummy_{i,t} + \gamma Control_{i,t} + Firm_i + Month_t + \epsilon_{i,t}$$

	Mean Rec	Med Rec	Mean PRC	Median PRC
Coeffi	-0.0	-0.004	-0.023	-0.028
	(-0.055)	(-0.485)	(-4.742)	(-4.644)
Adj R-sqr(%)	0.065	0.048	0.242	0.171
N	515356.0	515356.0	501231.0	501236.0
Time Fixed Effect	Yes	Yes	Yes	Yes
Firm Fixed Effect	Yes	Yes	Yes	Yes
Control	Yes	Yes	Yes	Yes

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