

Do Managers Avoid Disclosing to High Frequency Traders?

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Abstract

Although high frequency trading has risen dramatically over the last 20 years, we have limited knowledge of how companies' disclosures are shaped by this new class of investors. Using an exogenous shock to managers' awareness of HFTs trading on 4:00 PM earnings announcements, we provide the first evidence that managers avoid disclosing to HFTs by delaying 4:00PM announcements to a later time, despite the fact that HFTs price earnings news more efficiently. We explore possible explanations for firms' avoidance of HFTs.

Key Words: Timing of Earnings Announcement; High Frequency Trading

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1. Introduction

High frequency trading has risen dramatically over the last 20 years, surpassing 50% of all traded volume by 2012, but its presence has triggered a heated debate between regulators, investors, and economists about its costs and benefits (Goldstein, Kumar, and Graves [2014]). Proponents claim that high frequency trading improves the price discovery process and increases liquidity (Hendershott, Jones, and Menkveld [2011]; Brogaard, Hendershott, and Riordan [2014]); opponents argue that high frequency trading (HFT hereafter) increases volatility, raises the cost of informed trading, and creates an unlevel playing field for non-high frequency investors (SEC Concept Release [2010]; Kirilenko, Kyle, Samadi, and Tuzun [2017]; Korajczyk and Murphy [2018]). Yet given the increasing importance of HFT, we know little about how the corporate world responds to high frequency traders (HFTs). Exploiting a unique setting of 4:00 PM earnings announcements on which only HFTs can trade before the market closes, we study whether firms delay their earnings announcements to avoid disclosing to HFTs.¹

Managers have potentially conflicting disclosure incentives with respect to HFTs. The popular press often highlights excessive volatility induced by HFTs, such as the Flash Crash in 2010 (Kirilenko et al. [2017]). If managers are concerned about excess volatility, companies may avoid disclosing to HFTs to prevent big swings in their stock prices. In addition, the speed advantage enjoyed by HFTs necessarily disadvantages non-high frequency investors. Both the data provider of the Michigan Consumer Sentiment Index and the SEC have responded to HFTs' speed advantage by removing layered data distribution systems that uniquely benefitted HFTs (Hu, Pan,

¹ Although we generally refer to HFTs as a single group linked by their speed of trading, they actually vary widely in the trading strategies they execute (O'Hara [2015]). Some HFTs act as market makers, some split up and execute large orders at a lower cost, and others trade on released news. This last group of HFTs, otherwise known as event arbitrage strategists, process news automatically and try to trade first to make profits.

and Wang [2017]; Rogers, Skinner, and Zechman [2017]). To the extent that a company desires a level playing field for all investors, they should also avoid making disclosures to HFTs that disadvantage others.²

Existing academic literature, however, shows that HFTs speed the incorporation of earnings news into prices, making the process more efficient and reducing post-announcement drift (Bhattacharya, Chakrabarty, and Wang [2018]; Chakrabarty, Moulton, and Wang [2018]). If managers prefer more efficient pricing of their disclosures, then they may favor disclosing to HFTs. It is also possible that companies behave strategically—disclosing good news to HFTs to be incorporated into prices more quickly and avoiding HFTs when they have bad news to delay price drops.³ Ultimately, it is an empirical question whether companies avoid disclosing, disclose strategically, or simply do not respond at all to HFTs.

One challenge in identifying how companies react to the rise of HFTs is the endogeneity between firm disclosures and high frequency trading. A typical cross-sectional regression of firms' reporting behavior on the level of HFTs' trades and orders would suffer from selection issues and reverse causality concerns. To overcome this challenge, we make use of a unique setting at the market close when only HFTs are able to trade on earnings news. Although stock markets are set to close at 4:00 PM, exchanges actually institute a closing cross to determine the final closing

² It is not clear whether companies care about how the trading profit on earnings news is divided among participants in the secondary market. It is plausible, however, that a firm's institutional owners prefer managers avoid disclosing to HFTs so that they have the first opportunity to trade and profit on earnings news. Institutional owners have the ability through numerous channels to make these disclosure demands known (Boone and White [2015]), and as potential long-term shareholders, we posit that managers are more likely to respond to the preferences of their institutional owners rather than short-term HFTs.

³ Firms' earnings announcement times are generally consistent from quarter to quarter. However, in our setting, firms that historically announce at 4:00 PM can avoid HFTs by delaying the announcement for only a few minutes, and therefore we consider this setting a potential low cost means of strategic disclosure.

price.⁴ This closing process completes strictly after 4:00 PM, but often within one second.⁵ During this time period between 4:00 PM and the actual close (“closing window”), regular trading still occurs. If a firm releases earnings at exactly 4:00 PM, HFTs have the opportunity and speed to process the announcement and trade on it during the closing window, before the final closing price is set. On the contrary, if a company delays the earnings announcement by even a minute, then they reduce the likelihood and extent that their disclosure is traded by HFTs.⁶

Our research design utilizes an exogenous shock that increases companies’ awareness about HFT trading during the closing window to examine whether managers change their earnings announcement times in response to HFT. The Wall Street Journal published an article on February 6th, 2014 revealing that HFTs traded on Ulta Salon Cosmetics & Fragrance Inc.’s earnings news before the market finished closing despite the fact that Ulta released its earnings at 4:00 PM. Specifically, on December 5th, 2013, within 50 milliseconds of Ulta’s earnings release at 4:00 PM, nearly \$800,000 of Ulta’s stock was sold by HFTs based on the negative earnings news. The selloff resulted in a drop in Ulta’s share price from \$122 to \$118 before the market closed.⁷

Several days later, Business Wire agreed in a deal with the New York attorney general’s office to stop providing direct feeds to HFTs on February 20th, 2014. PR Newswire and the NASDAQ stock exchange followed by recommending, but not requiring, that their customers and issuers delay 4:00 PM announcements by a few minutes to avoid HFTs. Given the responses by

⁴ See <https://www.nyse.com/article/nyse-closing-auction-insiders-guide> and https://www.nasdaqtrader.com/content/ProductsServices/Trading/Crosses/openclose_faqs.pdf for further details on the NYSE and NASDAQ closing auction processes.

⁵ We believe this closing window (less than one second) is too short for human traders to acquire, process, and trade on 4:00 PM earnings announcements, and therefore we assume any trading on earnings during this window is executed by HFTs.

⁶ HFTs often rely on highly liquid markets to execute their strategies. Although HFT after hours cannot be ruled out, it appears substantially reduced given the lower volume of trades and quotes.

⁷ See Figure 1 for additional details about this specific earnings announcement along with the closing process for a day leading up to this earnings release.

the news wire services and the NASDAQ stock exchange, we argue the Wall Street Journal article is a valid and exogenous shock that increases companies' awareness of HFT trading at 4:00 PM.

Using this setting, we first investigate whether HFTs are able to systematically exploit 4:00 PM earnings announcements before the market closes, and if so, by how much. We find that on the earnings announcement day, the magnitude of returns, volume, and volatility during the last minute of regular hours trading is greater for 4:00 PM announcements compared to announcements released between 4:01 and 4:15 PM.⁸ This difference in volume and volatility between 4:00 PM announcements and 4:01-4:15 PM announcements is more pronounced when there are more liquidity-taking HFTs.⁹ This evidence is consistent with the HFTs systematically trading before the market closes on earnings news released at 4:00 PM.

Next, we study how this HFT trading at the close affects the incorporation of earnings news into prices. We measure earnings response coefficients (ERCs) using TAQ returns from 3:59 to the close of the announcement day and find that closing minute ERCs are stronger for 4:00 PM announcements compared to announcements made between 4:01 and 4:15 PM. Moreover, the ERC is stronger for 4:00 PM announcements when the firm has high levels of liquidity-taking HFTs. These results suggest that HFTs are trading in the direction of the earnings surprise and increasing the efficiency with which earnings are priced. To examine how long this increased efficiency for 4:00 PM announcements exists, we test the ERCs measured from the market close of the announcement day to the next market open. We find a significant weaker overnight ERC for 4:00 PM announcements compared to 4:01-4:15 PM announcements. This result indicates that the

⁸ Throughout the paper when we refer to the "last minute of regular hours trading," our measurement window runs from 3:59 PM to the actual market close shortly after 4:00 PM., and therefore includes any HFT trading during the closing window.

⁹ Event arbitrage HFTs usually cross the spread to execute trades, and therefore are liquidity "takers" as opposed to liquidity "makers" (i.e., market makers). Empirically, we cannot identify specific HFT trading strategies in the data, however, we are able to proxy for liquidity "taking" HFTs in general. As such, we expect firms with high liquidity-taking HFTs to see greater volume and volatility in the last minute of trading for 4:00 PM announcers.

strong response to earnings at the close for 4:00 PM announcements is offset, as expected, by a weaker response to earnings in the afterhours trading period.¹⁰ Although the price difference at the close is short lived, it is economically significant. The returns from 3:59 to 4:00 PM make up almost 9% of total returns from 3:59 PM to the next open for 4:00 PM announcements.

After showing that HFTs do trade on 4:00 PM earnings announcements and are able to move closing prices significantly to incorporate earnings news, we then study whether managers change their earnings announcement timing to avoid disclosing to HFTs. First, we examine the determinants for 4:00 PM announcements before the shock to the awareness of HFTs' trading at the market close. We find that companies that announce earnings at 4:00 PM do it consistently, but the choice is unrelated to the firm's earnings surprise, historical performance, or institutional ownership. These findings are consistent with the conjecture that companies are not aware of HFTs trading at the close prior to the Wall Street Journal article and therefore 4:00 PM announcements are similar to 4:01-4:15 PM announcements.

After the shock increases companies' awareness of HFTs' trading during the market close, we observe significantly fewer 4:00 PM announcements in 2014 and 2015 compared to 2012 and 2013; and the decrease in 4:00 PM announcements in 2014 and 2015 is largely offset by an increase in announcements at 4:01 and 4:05 PM. Further, cross-sectional analyses indicate that companies with higher liquidity-taking HFTs are less likely to release earnings at 4:00 PM in the post-event period. These findings indicate that companies, on average, avoid 4:00 PM announcements to stay away from HFTs.

As we discuss previously, there are multiple reasons why firms may delay announcements to avoid HFTs. One possibility is that managers want to provide their institutional owners the first

¹⁰ In untabulated analyses, we do not find a significant difference in pricing efficiency if we start the window from 3:59 pm on the announcement date and end the window at the market open of the next day.

opportunity to trade on earnings news. We find companies are less likely to announce at 4:00 PM after the shock to awareness if they have higher institutional ownership, more specifically higher transient institutional ownership.¹¹ Additionally, if managers prefer to reduce volatility, they may avoid disclosing to HFTs when their earnings news is more uncertain or more complex and therefore more likely to require human evaluation for appropriate pricing. Using analyst dispersion and intangible assets to proxy for uncertainties, our results do not find much evidence for uncertainty avoidance. Interestingly, we do not find evidence of strategic disclosure either. The likelihood of delaying earnings news to after 4:00 PM does not differ between good and bad earnings news.

We contribute to the literature in three ways. First, we provide evidence regarding managers' preferences with regard to disclosure and HFTs. While prior literature indicates HFTs effectively price hard news, including earnings announcements (Zhang [2017]; Rogers et al. [2017]; Chakrabarty et al. [2018]), there is also evidence that HFTs may impose greater adverse selection costs on slow traders (Chaboud [2014]; Hoffman [2014]) and in some cases may raise spreads and lower liquidity (Menkveld and Zoican [2017]; Malinova, Park, and Riordan [2018]). Our study moves beyond how HFTs affect capital markets to examine whether managers respond to this new class of trader by changing their disclosure timing.

Second, the paper is related to the literature on earnings announcement timing. Prior literature has documented a gradual shift in earnings announcement timing from regular trading hours to outside of regular trading hours. Patell and Wolfson (1984) find 67% of their sample in 1976/1977

¹¹ Using the Bushee and Noe (2000) classification, transient institutional owners are the most likely to trade on earnings news and therefore are the most likely to want to trade first on the news and avoid HFTs. Dedicated investors hold the stocks over long periods and are unlikely to trade on any given piece of news, while quasi-indexers have diverse holdings and do not trade on firm-specific news. As such, we do not expect as strong of preferences from dedicated and quasi-indexing institutional owners.

announce during regular hours, while Lyle, Rigsby, Stephan, and Yohn (2018) document more than 95% of firms announce outside of regular trading hours from 2006 to 2015. Because the change has been so gradual and so complete, academics have only been able to conjecture on why it has occurred. With the expansion of alternative trading systems in the 1990s and 2000s, two new types of traders arose in the regular trading hour: retail and algorithmic. It's not clear whether managers are shifting earnings announcement to after hours to avoid unsophisticated retail traders or to avoid HFTs. In this study, we shed light on why this gradual change may have occurred by examining managers' disclosure preferences with respect to HFTs. We provide the first evidence that managers avoid disclosing to HFTs, despite the fact that they on average improve the efficiency with which earnings are priced.

Third, we contribute to the HFT literature examining how HFTs affect the pricing of firm news. Prior literature has found that HFTs over the course of a trading day improve the efficiency with which earnings are priced (Bhattacharya et al. 2018; Chakrabarty et al. 2018). While our results are similar, namely that HFTs price earnings in the direction of the earnings news, we utilize a more recent and comprehensive sample. Moreover, our test examines the pricing over a very short window immediately after earnings are released, as compared to the whole announcement day, and therefore we show that HFTs are efficient even when they are the first traders on earnings news. In addition, we provide the first broad sample empirical evidence that HFTs trade on 4:00 PM earnings announcements during the market close process. Exchanges, news wires, and managers are clearly concerned about this trading occurring, but previous evidence was anecdotal. Detecting the effect in a large sample shows the HFT trading is not a rare occurrence.

2. Literature and Hypotheses

2.1 High Frequency Trading

Although all HFTs are linked by their ability to process information and submit, monitor, and cancel orders at extraordinarily high speeds, they are actually made up of a diverse range of different trading strategies (O'Hara [2015]). Some HFTs function as market makers, while others focus on executing large orders as efficiently as possible (Hasbrouck and Saar [2013]; Korajczyk and Murphy [2018]). Statistical arbitrage HFTs trade on correlations between various stocks, futures, etc. Order anticipation strategies are perhaps the best known, as these try to predict future order flow based on current order flow and trade ahead of incoming orders (Yang and Zhu [2017]).

Because our study is concerned with the release of earnings announcements, event arbitrage HFTs are most relevant. Event arbitrage HFT trades in the direction of news, like non-high frequency traders, but processes the news automatically and trades extremely quickly. Prior empirical literature shows HFT prices hard information releases extremely quickly. Zhang (2017) utilizes trade data from NASDAQ that specifically identifies trades from HFTs and examines the stock market reaction to hard news (futures returns shocks and VIX returns shocks) and soft news (news articles). Zhang finds that HFTs dominate trading in response to hard news, reacting strongly within ten seconds and relinquishing their position within two minutes. Non-HFTs, however, are the primary traders in response to soft information. Scholtus, van Dijk, and Frijns (2014) find similar results using message activity and fleeting orders as proxies for high frequency activity and macroeconomic news announcements as events. They find a delay of even 300 milliseconds significantly reduces the profitability of trading on these news announcements. Rogers et al. (2017) document that some traders receive Form 4 insider trading filings up to 30 seconds early from an SEC subscription, and this substantially reduces the profitability of trading on the filing at the

public release. Event arbitrage can have longer term effects beyond reacting to news within fractions of a second. Chakrabarty et al. (2018), using the same specifically identified HFT trades as Zhang (2017), finds HFT trades following an earnings announcement not only increase the speed at which the news is incorporated into prices, but also mitigate the delayed pricing due to investor inattention. Overall, the evidence indicates event arbitrage HFTs effectively price hard news, including earnings announcements.

HFT activity is not without its drawbacks, however. HFTs have generated headlines for multiple brief market crashes, including when a trading algorithm triggered the “flash crash” of 2010 by executing a large sell order of the E-Mini S&P (Kirilenko et al. [2017]).¹² Beyond excess volatility, regulators and investors are concerned that HFTs create an unlevel playing field, advantaging fast traders with a technological advantage over slower traders (SEC Concept Release [2010]). The academic literature finds HFTs may impose greater adverse selection costs on slow traders (Chaboud [2014]; Hoffman [2014]), and in some cases may raise spreads and lower liquidity (Menkveld and Zoican [2017]; Malinova, Park, and Riordan [2018]). The negative effects of HFT can even be intentional; some HFTs cause volatility and adverse selection through quote stuffing and spoofing (SEC Concept Release [2010]; Egginton, Van Ness, and Van Ness [2016]).

While the prior literature has investigated how HFTs affect our capital markets, it remains unknown how managers respond to HFT activity. Our study examines whether HFTs affect the timing of mandatory firm disclosures.

2.2 Earnings Announcement Timing

There has been a gradual shift in the timing of earnings announcements from releases

¹² According to the CFTC-SEC Staff Report regarding the flash crash, a sell order from a mutual fund complex for the E-Mini S&P 500 futures contract was executed by an automated algorithm. The sell order consumed the available liquidity, causing prices to drop. Prices fell further as HFTs added additional selling pressures.

during regular trading hours to releases outside of regular hours. Patell and Wolfson (1984) document that 67% of their sample in 1976/1977 announce during regular hours. Lyle et al. (2018), however, find more than 95% of firms announce outside of regular trading hours from 2006 to 2015. Because this shift has been so gradual and so complete over time, no studies have thoroughly examined why it has occurred.

The prior literature has proposed two potential explanations for this shift. First, announcing after hours allows time for traders to process the information before the market open (Doyle and Magilke [2009]). This processing time allows for more efficient pricing and lower volatility once trading begins (Lyle et al. [2018]).¹³ Second, managers may prefer announcing after hours because the proportion of sophisticated traders is the highest (Jiang, Likitapiwat, and McInish [2012]). Over the last 30 years, the number of Electronic Communication Networks (ECNs) and other Alternative Trading Systems (ATs) have grown immensely and allowed after-hours trading to become more frequent and accessible for sophisticated traders. Barclay and Hendershott [2003, 2004] find that informed traders dominate after-hours trading sessions. Jiang et al. [2012] support this view, showing after-hours trading effectively prices earnings releases. Michaely et al. [2014] suggest that SOX and Reg FD may have pushed firms to disclose after hours, as they can comply with the requirement to disclose to all investors at once, but still allow sophisticated traders to trade first. While the prior research has focused on whether managers prefer sophisticated after-hours investors over retail noise traders, we examine managers' disclosure preferences with respect to a new class of traders, HFTs.

¹³ This explanation does not account for two empirical stylized facts. First, after hours announcements are roughly evenly split between the evening, after the market close, and the morning, before the market open (Lyle et al. [2018]). If managers were solely maximizing processing time, presumably they would all announce in the evening. Second, the rise of after-hours trading has allowed sophisticated investors to trade on earnings during the after-hours period. Thus, the processing time may only be useful for retail traders who have to wait until the market open to trade.

Relatedly, there is a debate in prior literature on whether companies announce news in after-hours to hide bad news. The basic results from Gennotte and Trueman [1996] show that the impact of the disclosure is expected to be stronger if it occurs during trading hours rather than after the market has closed, so managers should prefer to disclose negative news after-hours. Consistent evidence is found in (Patell and Wolfson [1982] and DellaVigna and Pollet [2009]). Doyle and Magilke (2009), however, find no evidence of strategic behavior by only examining firms that switch announcement times. More recently, using the change and schedule of earnings announcement timing, deHaan, Shevlin, and Thornock (2015) adds to the debate by confirming the existence of strategic incentive that managers disclose bad news when they expect investors to be less attentive (e.g., after-hours). Our paper expands this debate by investigating whether managers strategically disclose their earnings news to HFTs to highlight good news and hide bad news.

2.3 High Frequency Trading and Managers' Disclosure Preferences

Our research question asks whether managers change their earnings announcement timing to avoid having their disclosure priced by HFTs. We propose two reasons why managers might do so. First, if managers believe that HFTs add excess noise and volatility into prices, we expect they will avoid announcements when HFTs have a strong ability to trade. Despite the fact that the academic literature finds HFTs improve the pricing of earnings on average, the popular press widely covers the flash crashes and excessively volatile events that are driven by HFTs (Lewis [2014]). It's plausible, therefore, that managers view HFTs as undesirable and delay their disclosures into the after-hours period to avoid them.

Second, managers may be catering to the disclosure preferences of their institutional investors. Prior literature finds HFTs create an unlevel playing field with their speed advantage.

Further, we know that institutional owners have disclosure preferences with respect to management forecasts and managers respond to these preferences (Ajinkya et al. [2005]; Boone and White [2015]). If institutional owners are at a disadvantage to HFTs when trading on earnings news, they may demand after-hours disclosures mitigate this disadvantage.

There are, however, arguments why managers may not avoid disclosing to HFTs or may even prefer HFT trading. First, prior literature speculates that managers may disclose after-hours because the proportion of sophisticated traders is the highest at this time and it will lead to more efficient pricing of news (Barclay and Hendershott [2003, 2004]; Jiang et al. [2012]). If HFTs improve the efficiency with which earnings is priced on average (Bhattacharya et al. [2018]; Chakrabarty et al. [2018]), managers may in fact seek out the opportunity to disclose to HFTs.

In addition, it is also possible that managers disclose strategically to HFTs. The prior literature generally concludes that managers strategically disclose bad news when they expect investors are less attentive. If managers are aware that HFTs will quickly price released news, they may disclose good news when HFTs are present and bad news after-hours when they are not. Ultimately, it is an empirical question how HFTs affect managerial disclosure preferences.

3 Data and Research Design

3.1 Data

We begin with a sample of all quarterly earnings announcements between 2012 and 2015 (61,160 observations, see Table 1 Panel A for additional detail). We join our sample of quarterly earnings announcements to CRSP, Compustat, I/B/E/S, TAQ, and EDGAR MIDAS, dropping any quarters that are missing required variables (33,928 observations remaining). We further delete observations with a stock price less than \$5 or market capitalization below \$10M. Last, we keep only firm-quarters with earnings announcement times between 4:00 and 4:15 PM (11,251

observations remaining).¹⁴

Table 1, Panel B presents summary statistics for our sample. We define *ClosingEA* as an indicator equal to one if the firm announces earnings at 4:00 PM, and 0 otherwise. Approximately 14% of earnings announcements between 4:00 and 4:15 PM occur at 4:00 PM. Returns during the last minute of the regular hours trading period (*ClosingReturns%*) on the announcement day make up about 1.7% of total daily returns from close to close. Volume (*ClosingVolume%*) and volatility (*ClosingVolatility%*) are substantially higher at 6.3% and 18.5% of the day's volume and volatility, respectively. Earnings surprises are slightly positive on average, and institutions own about 69% of outstanding shares. In untabulated analyses, we find the most popular announcement times within this window are 4:00, 4:01, and 4:05 PM. For a given announcement at one of these three times, approximately two thirds of firms will maintain the same announcement time in the next quarter. For announcements outside of these three minutes, the autocorrelation in announcement time is significantly lower.

Table 2 presents a correlation matrix. We observe that the closing minute returns, volume, and volatility are all positively correlated with 4:00 PM announcements. Performance (*SUE*, *LagReturns*, and *ROA*) is not significantly associated with the decision to announce at 4:00 PM.

3.2 Research Design

One challenge in identifying how companies react to the rise of HFTs is the endogeneity between firm disclosures and high frequency trading. A typical cross-sectional regression of firms' reporting behavior on the level of HFTs' trades and orders would suffer from selection issues and reverse causality concerns. To overcome this challenge, we make use of a unique setting at the market close when only HFTs are able to trade on earnings news.

¹⁴ We discuss the rationale for this last filter in Section 3.2 on our research design.

As we discuss in Section 1, markets do not close precisely at 4:00 PM, but rather exchanges institute a closing cross to determine the final closing price. This closing process usually completes within a second after 4:00 PM, but until then regular trading still occurs. If a firm releases earnings at exactly 4:00 PM, HFTs have the opportunity and speed to process the announcement and trade on it during the closing window, before the final closing price is set. Figure 1 shows a summary of the closing process for Ulta Salon Cosmetics & Fragrance Inc. on two days. On December 5, 2013, Ulta released negative earnings news at exactly 4:00 PM. From 3:59 to 4:00 PM, 30,946 shares were traded on 199 trades, but the stock price stayed relatively constant, moving from 121.76 to 121.80. The closing cross did not occur until 7/10ths of a second after 4:00 PM. During this window between 4:00 and 4:00.687 PM, 17,670 shares were traded on 68 trades, and the stock price dropped from 121.80 to 118.00. Given that the market had less than a second between the 4:00 PM earnings release and the market close, HFTs were the only traders capable of processing and trading on the negative earnings news in this window, driving the price down 3% over less than a second. We also present the closing process on December 2, 2013, a day without any news released by Ulta. We observe no trades between 4:00 PM and the market close.

Our research design utilizes an exogenous shock that increases companies' awareness about HFT trading during the closing window to examine whether managers change their earnings announcement times in response to this HFT trading. The Wall Street Journal published an article on February 6th, 2014 revealing that HFTs traded on Ulta Salon Cosmetics & Fragrance Inc.'s earnings news before the market finished closing despite the fact that Ulta released its earnings at 4:00 PM. Several days later, Business Wire agreed in a deal with the New York attorney general's office to stop providing direct feeds to HFTs on February 20th, 2014. PR Newswire and the NASDAQ stock exchange followed by recommending, but not requiring, that their customers and

issuers delay 4:00 PM announcements by a few minutes to avoid HFTs. Given the responses by the news wire services and the NASDAQ stock exchange, we argue the Wall Street Journal article is a valid and exogenous shock that increases companies' awareness of HFT trading at 4:00 PM.

As such, we believe we have an ideal setting to test managers preferences with regard to HFTs. Prior to the Wall Street Journal article, firms that announced at 4:00 PM were largely unaware that HFTs could trade on their earnings before the market close. After the article, awareness of HFT trading at the close increases exogenously and we can measure firm responses. Importantly, *only* HFTs are able to trade in this window because the timeframe is so short, and therefore any change in disclosure timing must be in response to HFTs and not to other types of traders (e.g., retail traders during regular trading hours).

Prior literature suggests that managers may alter their disclosure timing strategically, for example disclosing bad news on Friday evenings when investors are less attentive (Michaely et al. [2014]). Given that announcement timing is not fully random, we restrict our sample to announcements between 4:00 PM and 4:15 PM. We believe this eliminates any strategic aspect of the announcement time choice. We assume that there is no difference in disclosure cost or investor attention within this short window and that managers who announce at 4:00 PM could easily announce at 4:05 PM and vice versa. As such, we expect our tests face less risk of omitted correlated variables.¹⁵

4 HFTs and 4:00 PM Announcements

4.1 Determinants of 4:00 PM Announcements

We explore the determinants of 4:00 PM announcers in Table 3. Beginning with our sample described in Section 3.1, we keep firm-quarters in 2012 and 2013 prior to the Wall Street Journal

¹⁵ Our results are largely robust, qualitatively and quantitatively, to expanded samples, including 4:00-4:30 PM announcements, all evening announcements, and all announcements.

article revealing the HFT trading at the close. This sample allows us to explore whether 4:00 PM announcers differ from 4:01-4:15 PM announcers before managers are aware that HFTs can trade on earnings at the close. While prior literature has investigated the decision to announce before, during, or after regular trading hours, there are no predictions regarding when firms will announce within these windows, more specifically during the fifteen minute window after the close. In Table 3, we examine univariate differences in potential determinants of 4:00 PM announcements.

We test the following variables. *LagClosingEA* is the prior quarter's value of *ClosingEA*. We measure announcement news using unexpected earnings and ROA. *SUE* is standardized unexpected earnings, calculated using the analyst consensus mean forecast. *ROA* is income divided by total assets. To account for events in the quarter leading up to an earnings announcement, we look at historical returns, trading volume, and volatility. *LagReturns* are the cumulative returns over the 90 days prior to the earnings announcement. *LagTurnover* is the average daily share turnover over the 90 days prior to the earnings announcement. *LagVolatility* is the standard deviation of daily returns over the 90 days prior to the earnings announcement. We further examine firm characteristics. *Q4* is an indicator equal to 1 if it is the firm's fourth fiscal quarter. *Size* is the natural log of the market value of equity. *BtM* is the book value of equity divided by the market value of equity. We account for the firm's information environment using the number of analysts following the firm (*AnalystFollowing*) and the dispersion in analyst forecasts (*Dispersion*). Finally, given that institutional owners have disclosure preferences (Ajinkya et al. [2005]; Boone and White [2015]), we investigate whether the level of institutional ownership (*InstitutionalOwnership*) and institutional ownership concentration (*InstitutionalConcentration*) differ between 4:00 PM and 4:01-4:15 PM announcements. The former is defined as the percentage of shares owned by institutions making 13-f filings. The latter is the concentration of ownership

using the Herfindahl-Hirschman Index.

In Table 3, Panel A, we find the largest difference between 4:00 PM and non-4:00 PM announcements is *LagClosingEA*. For 4:00 PM announcements, 69% announced at 4:00 PM in the prior quarter as well, compared to only 4.4% for non-4:00 PM firms. 4:00 PM announcing firms are slightly smaller on average (approximately \$200M in market capitalization) and have one fewer analyst on average covering the firm. Difference in *LagTurnover* is statistically significant, but is economically small.

In Table 3, Panel B, we perform the same analysis but in multivariate form. Our model is as follows:

$$\begin{aligned} \text{ClosingEA} = & \alpha + \beta_1 \text{LagClosingEA} + \beta_2 \text{SUE} + \beta_3 \text{LagReturns} + \beta_4 \text{LagVolatility} \\ & + \beta_5 \text{LagTurnover} + \beta_6 \text{Q4} + \beta_7 \text{Size} + \beta_8 \text{BtM} + \beta_9 \text{ROA} \\ & + \beta_{10} \text{AnalystFollowing} + \beta_{11} \text{Dispersion} + \beta_{12} \text{InstitutionalOwnership} \\ & + \beta_{13} \text{InstitutionalConcentration} + \beta \text{IndustryFixedEffects} \\ & + \beta \text{YearFixedEffects} + \epsilon \end{aligned}$$

All variables are measured at the firm-quarter level (firm and time subscripts are omitted) and are defined previously.

We find that *LagClosingEA* is positive and significant at the 1% level. The remaining variables, with the exception of *Size*, are not significant. Overall, Table 3 suggests that differences between firms that announce at 4:00 PM compared to 4:01-4:15 PM are small, but once the choice is made it often carries over into future quarters. Moreover, there is no obvious strategic motive for this announcement time, as we find no differences in our performance proxies (*SUE* and *ROA*).

4.2 HFTs' Trading at 4:00 PM Announcements

Before we test how managers respond to HFTs, we first must determine whether HFTs

systematically trade on 4:00 PM earnings announcements before the market closes. The evidence to date is anecdotal, and if this type of trading is not widespread, the Wall Street Journal article is unlikely to affect managers' disclosure timing. As it usually takes less than a minute for the market to close, the regular trading session likely ends before news announced during 4:01-4:15 PM. By contrast, we expect HFTs are able to submit orders driven by 4:00 PM earnings announcements before the market closes, so their trading will be included in the last-minute trading.

In this section, we formally test whether HFTs are able to trade on 4:00 PM announcements by comparing the magnitude of returns, volume, and volatility during the last minute of regular hours trading between 4:00 PM announcements and 4:01-4:15 PM announcements. We use the following model:

$$\begin{aligned}
 & \textit{ClosingReturns (Volume/Volatility) \%} \\
 & = \alpha + \beta_1 \textit{ClosingEA} + \beta_2 \textit{SUE} + \beta_3 \textit{LagReturns} + \beta_4 \textit{Q4} + \beta_5 \textit{Size} + \beta_6 \textit{BtM} \\
 & + \beta_7 \textit{ROA} + \beta_8 \textit{AnalystFollowing} + \beta_9 \textit{Dispersion} \\
 & + \beta_{10} \textit{InstitutionalOwnership} + \beta_{11} \textit{InstitutionalConcentration} \\
 & + \beta \textit{FixedEffects} + \beta \textit{YearFixedEffects} + \epsilon
 \end{aligned}$$

CloseReturn(Volume/Volatility)% is defined as the percentage of earnings announcement date returns (volume/volatility) that occur during the last minute of the regular hours trading period, including the closing window. The variable is calculated as returns (volume/volatility) from 3:59 PM to the market close on the earnings announcement date, scaled by returns (volume/volatility) from the prior day's close to the announcement day close. Other variables are defined previously in Section 4.1.

β_1 captures the differences between 4:00 PM announcements and 4:01-4:15 PM announcements across the three proxies for trading activities in the last minute during regular

trading hours. In Panel A of Table 4, we find that β_1 is positive and significant at 1% for all trading measures in columns (1) through (3). We include the determinants for 4:00 PM announcements as controls, even though only size is a significant determinant. To further exclude the possibility that our results are due to any unobservable time-invariant firm characteristics, we include firm fixed effects in columns (4) through (6), finding consistent results.

In Panel B of Table 4, we more directly test whether HFTs contribute to the difference in the last-minute trading. Specifically, we interact 4:00 PM announcements with the company's average level of liquidity-taking HFT over the 60 days prior to earnings announcement date. It is liquidity-taking HFTs who are more likely to do news-arbitrage, whereas liquidity-providing HFTs are less likely to trade on news but more likely to serve as market makers and trade on order book dynamics (O'Hara [2015]). Thus, we expect closing minute activity to be stronger for 4:00 PM announcements when the firm has a high level of liquidity-taking HFT. *LiquidityTaking_HFT* is defined as the first principal component of trade size and the odd lot volume ratio, measured over the 60 days prior to the earnings announcement date.¹⁶ The odd lot volume ratio is the volume of trades in odd lot sizes divided by the total volume of trades. In Panel B of Table 4, we find the coefficient of *LiquidityTaking_HFT* is significantly positive for both the last-minute volume and volatility, suggesting that liquidity-taking HFTs increase the last minute trades regardless of whether there is an earnings announcement at 4:00 PM. Most importantly, the coefficient of the interaction term *LiquidityTaking_HFT* \times *ClosingEA* is significantly positive for both the last-minute volume and volatility. This indicates that that the last-minute trading for 4:00 PM announcers increases with liquidity-taking HFTs. Overall, the evidence from Table 4 suggests that there is systematic and widespread high frequency trading on 4:00 PM earnings announcements.

¹⁶ These two proxies have been associated with liquidity-taking HFT activity in the prior literature (Weller [2017]).

4.3 HFTs' Pricing Efficiency

Next we study whether high frequency trading on 4:00 PM earnings announcements is efficient. As we discuss in Section 2, how managers respond to HFTs may depend on whether HFTs increase or decrease the efficiency with which earnings news is priced. In Table 5, we study whether and how HFTs' trading affects the last-minute ERCs by running the following model:

ClosingReturns

$$\begin{aligned} &= \alpha + \alpha_1 \text{ClosingEA} \times \text{SUE} + \beta_1 \text{ClosingEA} + \beta_2 \text{SUE} + \beta_3 \text{LagReturns} \\ &+ \beta_4 \text{Q4} + \beta_5 \text{Size} + \beta_6 \text{BtM} + \beta_7 \text{ROA} + \beta_8 \text{AnalystFollowing} + \beta_9 \text{Dispersion} \\ &+ \beta_{10} \text{InstitutionalOwnership} + \beta_{11} \text{InstitutionalConcentration} \\ &+ \beta \text{FixedEffects} + \beta \text{YearFixedEffects} + \epsilon \end{aligned}$$

ClosingReturns is the stock returns during the last minute of the day on which earnings are announced, calculated as the closing price less the price at 3:59 PM, scaled by the 3:59 PM price. Other variables are defined previously in section 4.1. The main variable of interest is *ClosingEA* × *SUE*. A positive α_1 suggests that HFTs' trading in the last-minute are in the same direction as the earnings surprise and HFTs help prices incorporate the earnings news more efficiently. We find consistent evidence in Table 5, in which the coefficient of *ClosingEA* × *SUE* is positive and significant at 1% for closing returns. Again, we find this effect is stronger if the firm has high liquidity-taking HFT.

Despite the short-term improvement in ERCs, it is not clear how long this difference in efficiency will persist. As such, we examine returns through the overnight trading period. In Table 6, we show results from the same model as in Table 5, except that the dependent variable is returns from the market close on the announcement day to the next market open (*OvernightReturns*). The coefficient of *ClosingEA* × *SUE* is negative and significant at 5% and 10% in the model with

industry fixed effects and firm fixed effects, respectively. Overall, evidence from Table 5 and Table 6 suggests that HFTs' trading in the last minute improves short-term price efficiency but the efficiency gain is short lived and mitigated by lower overnight efficiency.

5 Do companies avoid disclosing to HFTs?

5.1 The likelihood of 4:00 PM announcements before and after February 4, 2014

The previous section shows that HFTs trade on 4:00 PM announcements and their trading improves short-term price efficiency. Even though the improvement in price efficiency does not last long, there is no evidence that HFTs' trading hurts efficiency in any way. It is not clear why companies would want to avoid HFTs if efficiency is their only concern. Alternatively, if companies aim for a level playing field for all investors or cater to their institutional owners, then they may avoid disclosing to HFTs so their institutional owners are not at a disadvantage. It is thus an empirical question whether companies avoid disclosing, disclose strategically, or simply do not respond at all to HFTs.

Our identification strategy uses the release of the Wall Street Journal article discussed in Section 3.2 as an exogenous increase in the awareness of HFTs' trading at 4:00 PM. We define announcements prior to February 4, 2014, the date of the Wall Street Journal article, as the pre-shock period, and announcements after that date as the post-shock period. We then examine whether the likelihood of 4:00 PM announcements changes after managers become aware of HFT trading at the close.

Figure 1 presents the proportion of earnings announcements around the market close at 4:00 PM for announcements pre/post 2014. The figure shows a reduction in 4:00 PM announcements after 2014, and an increase in announcements at 4:01 and 4:05 pm. The figure is consistent with managers delaying their earnings announcements to avoid high frequency traders

at the close.

We further test the significance of the reduction of 4:00 PM announcements in Table 7. In Panel A, we first show a year-to-year change in the percentage of 4:00 PM earnings announcements among all earnings announcements (N=31,204). We show a significant downward trend *starting* in 2014. In particular, in 2012 and 2013, about 6% of earnings announcements are released at 4:00 PM. There are significant drops in the percentage of the 4:00 PM announcements in 2014 to 4.9% and in 2015 to 3.8%.¹⁷ Between the pre- and post-shock periods, fell by 1.4 percentage points (a 24% decline) and is significant at the 1% level.

In Panel B of Table 7, we exam whether companies are more likely to delay avoid 4:00 PM announcements in the post period by running the following model:

$$\begin{aligned} \text{ClosingEA} = & \alpha + \beta_1 \text{Post} + \beta_2 \text{SUE} + \beta_3 \text{LagReturns} + \beta_4 \text{LagVolatility} + \beta_5 \text{LagTurnover} \\ & + \beta_6 \text{Q4} + \beta_7 \text{Size} + \beta_8 \text{BtM} + \beta_9 \text{ROA} + \beta_{10} \text{AnalystFollowing} \\ & + \beta_{11} \text{Dispersion} + \beta_{12} \text{InstitutionalOwnership} \\ & + \beta_{13} \text{InstitutionalConcentration} + \beta \text{FixedEffects} + \beta \text{YearFixedEffects} \\ & + \epsilon \end{aligned}$$

Industry fixed effects are included in the first column, and firm fixed effects in the second column. The variable *Post* indicates the earnings announcement falls after the Wall Street Journal article in 2014 or 2015 when managers' awareness about HFT trading is higher. We find β_1 is negative and significant at 1% for both columns, suggesting, on average, companies are delaying their 4:00 PM announcements after the revelation of HFTs' abilities to trade on 4:00 PM announcements.

¹⁷ The downward trend not stopping by 2015 suggests that companies' awareness of HFTs' trading at 4:00 PM may not be instant, but rather gradual. This result is consistent with the NASDAQ exchange not issuing their recommendation to delay announcements until 2015.

5.2 What kind of companies avoid disclosing to HFTs?

Because there is no clear evidence that HFTs' 4:00 PM trading hurts efficiency, it is less likely that managers delay their earnings announcements out of concern for how efficiently their announcement is priced. An alternative explanation is that managers delay announcements to cater to their institutional owners. Specifically, when the liquidity-taking news-driven HFTs are less active, more trading profit will be left for after-hours institutional investors. In other words, if the delaying decision reflects companies' preference for institutional investors over HFTs, we should observe companies with more liquidity-taking HFTs and companies with a higher institutional ownership delay more.

In Table 8, we first add interactions of *Post* with several investor-base characteristics to the model we run in Panel B of Table 7. Columns (1) and (2) shows that companies that have a higher liquidity-taking HFTs around their previous earnings announcement are less likely to announce at 4:00 PM in the post period, suggesting companies are particularly avoiding liquidity-taking HFTs. In Columns (3) to (6), we find that companies with higher institutional ownership, especially higher transient institutional ownership, are more likely to delay their 4:00 PM announcements. This result is consistent with the conjecture that dedicated and quasi-indexing institutional investors might not care about the short-term price changes driven by HFTs trading on earnings news, but transient institutional investors might be the ones competing against HFTs over those short-term news-driven trades.

In Table 9, we run cross-sectional tests to verify that managers are not delaying their announcements based on concerns about pricing efficiency. In Table 9, we interact standardized unexpected earnings (*SUE*) with *Post*, finding the likelihood of avoiding 4:00 PM announcements does not vary with the earnings news. Likewise, we proxy for the complexity of the earnings news

using analyst dispersion (*Dispersion*) and the percentage of intangible assets (*IntangiblesPercent*). We expect that more complex or more uncertain earnings news will be more challenging for HFTs to price, and therefore if managers avoid HFTs for pricing efficiency concerns, they should be more likely to do so when there is high analyst dispersion or the company has a high percentage of intangible assets. We find both terms interacted with *Post* are insignificant. Overall, we find evidence with managers delaying earnings announcements to cater to institutional owners, and no evidence that they delay announcements out of concern for price efficiency.

6 Conclusion

In this study, we examine whether managers avoid releasing earnings announcements when HFTs are the first to trade on the news. We first document that HFT trading occurs systematically at the close for 4:00 PM announcements, resulting higher volatility and volume, specifically when the firm has high liquidity-taking HFT trading. Second, we show that this trading improves the efficiency with which earnings are priced, even though the effect is short-lived. As such, if managers are only concerned with efficiency, they should not avoid disclosing to HFTs.

Using an exogenous shock to managers' awareness of HFT trading, we find that managers are more likely to delay their announcements to after 4:00 PM once they become aware of HFT trading at the close. In addition, managers are more likely to delay when they have high liquidity-taking HFTs and high institutional ownership. Overall, our results are consistent with managers catering to their institutional owners who may prefer to have the first opportunity to trade on earnings news. We contribute to the literature by examining how a major new type of trader affects managers' disclosure preferences and shed some light on why managers have shifted earnings announcements to the after-hours period.

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Appendix A
Variable Definitions

<u>Variable</u>	<u>Definition</u>
<i>AnalystFollowing</i>	The number of analysts contributing to the consensus forecast.
<i>BtM</i>	The book value of equity divided by the market value of equity.
<i>ClosingEA</i>	An indicator equal to 1 if a given earnings announcement is released at 4:00 PM, and 0 otherwise.
<i>ClosingReturns</i>	Stock returns during the last minute of the day on which earnings are announced, calculated as the closing price less the price at 3:59 PM, scaled by the 3:59 PM price.
<i>ClosingReturns%</i>	The percentage of earnings announcement date returns that occur during the last minute of the regular hours trading period. The variable is calculated as returns from 3:59 PM to the market close on the earnings announcement date, scaled by returns from the prior day's close to the announcement day close.
<i>ClosingVolatility%</i>	The percentage of earnings announcement date volatility that occurs during the last minute of the regular hours trading period. The variable is calculated as volatility from 3:59 PM to the market close on the earnings announcement date, scaled by volatility from the prior day's close to the announcement day close.
<i>ClosingVolume%</i>	The percentage of earnings announcement date trading volume that occurs during the last minute of the regular hours trading period. The variable is calculated as trading volume from 3:59 PM to the market close on the earnings announcement date, scaled by trading volume from the prior day's close to the announcement day close.
<i>Dispersion</i>	The standard deviation of the analyst forecasts contributing to the consensus.
<i>Illiquidity</i>	The absolute value of returns scaled by the daily share turnover, averaged over the 90 days prior to the earnings announcement date.
<i>InstitutionalConcentration</i>	The institutional ownership concentration using the Herfindahl-Hirschman Index.
<i>InstitutionalOwnership</i>	The percentage of outstanding shares owned by institutions.

<i>InstitutionalOwnership_DED</i>	The percentage of outstanding shares owned by dedicated institutions, as defined in Bushee and Noe [2000].
<i>InstitutionalOwnership_QIX</i>	The percentage of outstanding shares owned by quasi-indexing institutions, as defined in Bushee and Noe [2000].
<i>InstitutionalOwnership_TRA</i>	The percentage of outstanding shares owned by transient institutions, as defined in Bushee and Noe [2000].
<i>LagReturns</i>	Cumulative stock returns over the 90 days prior to the earnings announcement date.
<i>LagTurnover</i>	Average daily stock turnover over the 90 days prior to the earnings announcement date.
<i>LagVolatility</i>	Average daily stock return volatility over the 90 days prior to the earnings announcement date.
<i>LiquidityTaking_HFT</i>	The first principal component of trade size and the odd lot volume ratio, measured over the 90 days prior to the earnings announcement date. The odd lot volume ratio is the volume of trades in odd lot sizes divided by the total volume of trades.
<i>OvernightReturns</i>	Stock returns from the close of the earnings announcement day to the next market open, calculated as the market open price less the prior day's closing price, scaled by the closing price.
<i>Post</i>	An indicator equal to 1 if the earnings announcement occurs after the Wall Street Journal article in 2014 and 2015, and 0 if it occurs in 2012 or 2013.
<i>Q4</i>	An indicator equal to 1 if it is the firm's fourth fiscal quarter.
<i>ROA</i>	Return on assets.
<i>Size</i>	The natural log of the firm's market value of equity, calculated as of the end of the fiscal quarter.
<i>Spread</i>	The daily bid-ask spread from CRSP averaged over the 90 days prior to the earnings announcement date.
<i>SUE</i>	Standardized unexpected earnings calculated using the analyst consensus mean forecast.

Figure 1
Closing Announcement Process: Ulta Beauty Example

Earnings Announcement (Dec. 5, 2013)

Non-Earnings Announcement (Dec. 2, 2013)

<u>Time</u>	<u>Price</u>		<u>Price</u>	<u>Time</u>	
3:59.000	121.76		126.67	3:59.000	
↓		<u>Regular Hours: 3:59 to 4:00 PM</u>		↓	
		199 Trades Executed 24			
		30,946 Shares Traded 2,751			
		0.03% Returns 0.17%			
4:00.000	121.80		126.88	4:00.000	
↓		<u>After 4:00 PM Before the Close</u>		↓	
		68 Trades Executed 0			
		17,670 Shares Traded 0			
		-3.12% Returns 0.00%			
4:00.687	118.00		126.88	4:00.052	
Market Close 4:00.688	118.00	<u>Closing Cross</u>	126.93	4:00.053	Market Close
		36,463 Shares Traded 9,313			
		0.00% Returns 0.04%			

Figure 2
Earnings Announcements around the Close

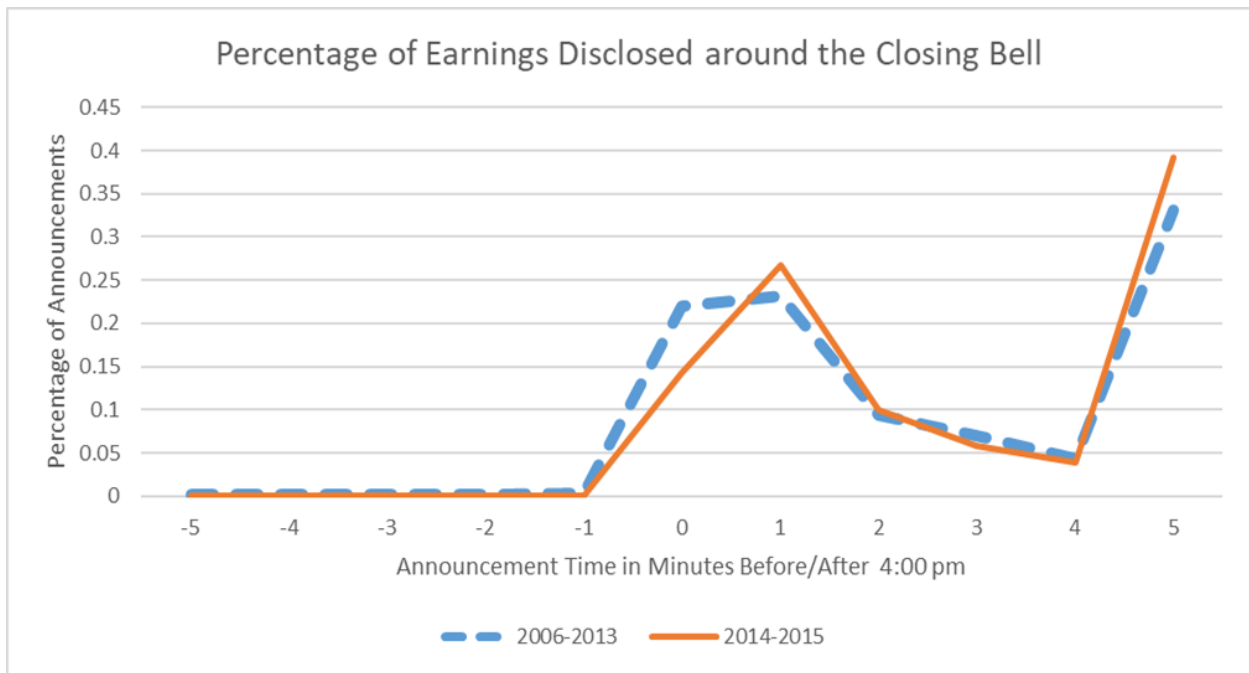


Table 1
Summary Statistics

Panel A: Sample Composition

	<u>N</u>
Quarterly announcements from 2012-2015	61,160
Less: missing controls	(27,232)
Less: price < \$5 and market cap < \$10M	(2,724)
Less: announcements outside of 4:00-4:15 PM	<u>(19,953)</u>
Final sample	11,251

Panel B: Summary Statistics^a

	<u>Mean</u>	<u>Std. Dev.</u>	<u>25th %</u>	<u>Median</u>	<u>75th %</u>
<i>ClosingEA</i>	0.140	0.347	0.000	0.000	0.000
<i>ClosingReturns</i>	0.000	0.003	-0.001	0.000	0.001
<i>OvernightReturns</i>	-0.001	0.065	-0.026	0.001	0.029
<i>ClosingReturns%</i>	0.017	0.623	-0.081	0.000	0.102
<i>ClosingVolume%</i>	0.063	0.066	0.023	0.039	0.078
<i>ClosingVolatility%</i>	0.185	0.182	0.073	0.127	0.226
<i>SUE</i>	0.001	0.006	0.000	0.001	0.002
<i>LagReturns</i>	0.045	0.184	-0.060	0.038	0.137
<i>LagVolatility</i>	0.022	0.011	0.015	0.020	0.027
<i>LagTurnover</i>	0.010	0.008	0.005	0.008	0.012
<i>Q4</i>	0.208	0.406	0.000	0.000	0.000
<i>Size</i>	7.371	1.524	6.270	7.185	8.266
<i>BtM</i>	0.453	0.374	0.197	0.357	0.617
<i>ROA</i>	0.001	0.058	-0.003	0.008	0.019
<i>AnalystFollowing</i>	10.696	7.871	5.000	8.000	15.000
<i>Dispersion</i>	0.042	0.088	0.010	0.020	0.040
<i>InstitutionalOwnership</i>	0.691	0.200	0.576	0.720	0.831
<i>InsitutionalConcentration</i>	0.071	0.063	0.040	0.053	0.077
<i>LiquidityTaking_HFT</i>	0.188	0.342	-0.039	0.156	0.396

^a See Appendix A for variable definitions.

Table 2
Correlation Matrix

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)	(19)
(1) <i>ClosingEA</i> ^{a,b}	1.00																		
(2) <i>ClosingMinuteReturns</i>	0.00	1.00																	
(3) <i>OvernightReturns</i>	-0.01	-0.00	1.00																
(4) <i>ClosingReturns%</i>	0.06*	-0.02*	0.00	1.00															
(5) <i>ClosingVolume%</i>	0.11*	-0.01	0.01	0.04*	1.00														
(6) <i>ClosingVolatility%</i>	0.20*	-0.01	0.00	0.10*	0.30*	1.00													
(7) <i>SUE</i>	-0.02	-0.00	0.27*	-0.00	0.01	-0.03*	1.00												
(8) <i>LagReturns</i>	0.01	0.01	0.07*	-0.00	-0.05*	0.01	0.04*	1.00											
(9) <i>LagVolatility</i>	-0.01	-0.00	-0.01	-0.01	-0.08*	-0.03*	-0.02*	0.01	1.00										
(10) <i>LagTurnover</i>	-0.03*	-0.01	-0.02*	-0.00	-0.26*	-0.20*	0.02	0.00	0.48*	1.00									
(11) <i>Q4</i>	0.01	-0.00	0.00	0.01	-0.09*	-0.01	0.01	0.09*	-0.04*	0.00	1.00								
(12) <i>Size</i>	-0.06*	-0.01	0.02	-0.00	-0.28*	-0.26*	0.02*	0.03*	-0.36*	0.12*	0.06*	1.00							
(13) <i>BtM</i>	0.01	0.00	-0.01	0.01	0.11*	0.09*	0.05*	-0.08*	-0.08*	-0.09*	0.01	-0.18*	1.00						
(14) <i>ROA</i>	0.00	-0.01	0.05*	-0.01	-0.00	-0.03*	0.13*	0.02*	-0.30*	-0.06*	0.03*	0.20*	0.04*	1.00					
(15) <i>AnalystFollowing</i>	-0.05*	-0.01	0.01	-0.00	-0.25*	-0.21*	0.02	-0.01	-0.17*	0.28*	0.08*	0.74*	-0.14*	0.12*	1.00				
(16) <i>Dispersion</i>	-0.00	-0.00	0.01	0.00	-0.05*	-0.00	-0.02*	0.01	0.08*	0.12*	0.02*	0.05*	0.06*	-0.03*	-0.01	1.00			
(17) <i>InstitutionalOwnership</i>	-0.02	-0.01	0.00	-0.02	-0.07*	-0.14*	0.02*	0.02	-0.15*	0.20*	0.03*	0.24*	-0.08*	0.12*	0.23*	0.01	1.00		
(18) <i>InstitutionalConcentration</i>	-0.00	0.00	-0.01	-0.00	0.08*	0.15*	-0.03*	-0.01	0.24*	-0.17*	-0.03*	-0.33*	-0.03*	-0.18*	-0.27*	0.01	-0.26*	1.00	
(19) <i>LiquidityTaking_HFT</i>	0.05*	-0.00	0.01	0.02	0.27*	0.16*	-0.01	-0.02*	-0.23*	-0.35*	-0.05*	-0.11*	-0.10*	0.09*	-0.24*	0.10*	-0.02*	0.03*	1.00

^a See Appendix A for variable definitions.

^b * indicates statistical significance at 10%.

Table 3
Closing Announcement Determinants

Panel A: Univariate Differences^{a,b}

	<u>ClosingEA=0</u> (N=4,407)	<u>ClosingEA=1</u> (N=867)	<u>Diff.</u>		<u>T-Stat</u>
<i>LagClosingEA</i>	0.044	0.689	-0.645	***	-65.574
<i>SUE</i>	0.001	0.001	0.000		1.397
<i>LagReturns</i>	0.074	0.071	0.003		0.400
<i>LagVolatility</i>	0.022	0.022	0.000		0.758
<i>LagTurnover</i>	0.010	0.009	0.001	*	1.629
<i>Q4</i>	0.210	0.202	0.008		0.563
<i>Size</i>	7.326	7.108	0.218	***	3.925
<i>BtM</i>	0.499	0.505	-0.006		-0.426
<i>ROA</i>	0.004	0.004	0.000		-0.077
<i>AnalystFollowing</i>	11.095	10.160	0.935	***	3.221
<i>Dispersion</i>	0.040	0.042	-0.002		-0.491
<i>InsitutionalOwnership</i>	0.735	0.725	0.010		1.197
<i>InsitutionalConcentration</i>	0.067	0.066	0.001		0.434

^a See Appendix A for variable definitions.

^b *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively.

Closing Announcement Determinants

Panel B: Multivariate Analysis^{a,b}

	(1)
	<i>ClosingEA</i>
<i>LagClosingEA</i>	3.7684*** (34.48)
<i>SUE</i>	-5.1690 (-0.70)
<i>LagReturns</i>	-0.1101 (-0.37)
<i>LagVolatility</i>	-2.6927 (-0.38)
<i>LagTurnover</i>	-4.8344 (-0.52)
<i>Q4</i>	-0.1354 (-1.07)
<i>Size</i>	-0.1471** (-2.35)
<i>BtM</i>	-0.2298 (-1.43)
<i>ROA</i>	0.7013 (0.65)
<i>AnalystFollowing</i>	0.0163 (1.43)
<i>Dispersion</i>	0.1911 (0.43)
<i>InstitutionalOwnership</i>	0.1350 (0.47)
<i>InstitutionalConcentration</i>	0.4009 (0.39)
<i>Constant</i>	-1.9943*** (-3.22)
Observations	5,029
Pseudo R-squared	0.390
Fixed Effects	Industry & Year

^a See Appendix A for variable definitions.

^b *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. Standard errors are clustered by earnings announcement date.

Table 4
Trading Activity at the Close

Panel A: Closing Minute Activity^{a,b}

VARIABLES	Industry Fixed Effects			Firm Fixed Effects		
	(1) <i>Closing Returns%</i>	(2) <i>Closing Volume%</i>	(3) <i>Closing Volatility%</i>	(4) <i>Closing Returns%</i>	(5) <i>Closing Volume%</i>	(6) <i>Closing Volatility%</i>
<i>ClosingEA</i>	0.0999*** (4.45)	0.0138*** (8.58)	0.0928*** (12.98)	0.1045*** (3.29)	0.0048* (1.95)	0.0727*** (7.88)
<i>SUE</i>	0.2426 (0.24)	0.1370 (1.44)	-0.5453* (-1.85)	1.1818 (0.98)	0.1454 (1.44)	-0.2049 (-0.64)
<i>LagReturns</i>	0.0012 (0.04)	-0.0163*** (-5.83)	-0.0013 (-0.13)	-0.0038 (-0.12)	-0.0141*** (-4.98)	0.0042 (0.42)
<i>Q4</i>	0.0162 (1.15)	-0.0103*** (-5.66)	0.0028 (0.68)	0.0163 (1.05)	-0.0100*** (-5.99)	0.0024 (0.56)
<i>Size</i>	0.0050 (0.73)	-0.0072*** (-8.68)	-0.0223*** (-12.01)	-0.0139 (-0.56)	-0.0124*** (-4.97)	-0.0283*** (-4.24)
<i>BtM</i>	0.0078 (0.38)	0.0016 (0.75)	0.0202*** (3.48)	-0.0402 (-0.80)	-0.0023 (-0.55)	-0.0010 (-0.08)
<i>ROA</i>	-0.1516 (-1.43)	0.0375*** (2.80)	0.0855** (2.25)	-0.0709 (-0.34)	-0.0125 (-1.04)	-0.0034 (-0.07)
<i>AnalystFollowing</i>	-0.0011 (-0.93)	-0.0009*** (-8.18)	-0.0005* (-1.68)	0.0010 (0.32)	0.0007*** (3.30)	-0.0001 (-0.11)
<i>Dispersion</i>	0.0095 (0.17)	-0.0158*** (-3.45)	0.0331 (1.61)	-0.1267 (-1.44)	-0.0048 (-0.81)	0.0065 (0.25)
<i>InstitutionalOwnership</i>	-0.0397 (-1.24)	-0.0042 (-1.17)	-0.0687*** (-7.51)	-0.0442 (-0.71)	-0.0043 (-0.71)	-0.0231 (-1.21)
<i>InstitutionalConcentration</i>	-0.1165 (-1.03)	0.0080 (0.75)	0.1871*** (4.98)	-0.1515 (-0.75)	0.0308** (2.03)	0.1470** (2.38)
<i>Constant</i>	-0.0488 (-0.96)	0.1722*** (10.40)	0.3505*** (3.63)	0.1416 (0.71)	0.1617*** (7.77)	0.3688*** (7.08)
Observations	11,251	11,251	11,251	11,251	11,251	11,251
Adjusted R-squared	0.003	0.236	0.143	0.003	0.441	0.241
Fixed Effects	Industry & Year	Industry & Year	Industry & Year	Firm & Year	Firm & Year	Firm & Year

^a See Appendix A for variable definitions.

^b *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. Standard errors are clustered by earnings announcement date.

Table 4, continued
Trading Activity at the Close

Panel B: Cross-Sectional Test of Closing Minute Activity^{a,b}

VARIABLES	Industry Fixed Effects			Firm Fixed Effects		
	(1)	(2)	(3)	(4)	(5)	(6)
	<i>Closing Returns%</i>	<i>Closing Volume%</i>	<i>Closing Volatility%</i>	<i>Closing Returns%</i>	<i>Closing Volume%</i>	<i>Closing Volatility%</i>
<i>ClosingEA</i>	0.0946*** (3.79)	0.0064*** (3.95)	0.0837*** (10.68)	0.0820** (2.36)	0.0022 (0.97)	0.0640*** (6.81)
<i>LiquidityTaking_HFT</i>	0.0116 (0.55)	0.0510*** (17.33)	0.0700*** (11.98)	0.0176 (0.36)	0.0623*** (12.22)	0.0557*** (3.66)
<i>ClosingEA</i> <i>x LiquidityTaking_HFT</i>	0.0198 (0.33)	0.0196*** (3.48)	0.0224 (1.24)	0.1119 (1.32)	0.0128* (1.96)	0.0432* (1.78)
<i>SUE</i>	0.2422 (0.24)	0.1517* (1.70)	-0.5240* (-1.84)	1.1845 (0.99)	0.1331 (1.32)	-0.2140 (-0.67)
<i>LagReturns</i>	0.0019 (0.06)	-0.0137*** (-5.10)	0.0022 (0.23)	-0.0024 (-0.08)	-0.0110*** (-3.88)	0.0072 (0.73)
<i>Q4</i>	0.0167 (1.18)	-0.0085*** (-4.91)	0.0052 (1.27)	0.0169 (1.09)	-0.0089*** (-5.46)	0.0035 (0.83)
<i>Size</i>	0.0049 (0.72)	-0.0074*** (-9.38)	-0.0226*** (-12.27)	-0.0196 (-0.77)	-0.0232*** (-8.46)	-0.0387*** (-5.43)
<i>BtM</i>	0.0102 (0.49)	0.0103*** (5.18)	0.0320*** (5.43)	-0.0390 (-0.77)	-0.0008 (-0.19)	0.0006 (0.05)
<i>ROA</i>	-0.1620 (-1.51)	0.0001 (0.01)	0.0347 (1.26)	-0.0694 (-0.33)	-0.0154 (-1.27)	-0.0053 (-0.11)
<i>AnalystFollowing</i>	-0.0010 (-0.80)	-0.0003** (-2.47)	0.0004 (1.15)	0.0011 (0.34)	0.0007*** (3.42)	-0.0001 (-0.08)
<i>Dispersion</i>	0.0048 (0.08)	-0.0366*** (-6.38)	0.0046 (0.22)	-0.1273 (-1.44)	-0.0037 (-0.64)	0.0072 (0.28)
<i>InstitutionalOwnership</i>	-0.0415 (-1.29)	-0.0109*** (-3.02)	-0.0777*** (-8.51)	-0.0417 (-0.66)	0.0021 (0.35)	-0.0173 (-0.89)
<i>InstitutionalConcentration</i>	-0.1162 (-1.02)	0.0125 (1.27)	0.1935*** (5.19)	-0.1554 (-0.77)	0.0215 (1.43)	0.1383** (2.27)
<i>Constant</i>	-0.0572 (-1.04)	0.1329*** (7.63)	0.2964*** (3.14)	0.1805 (0.90)	0.2297*** (10.29)	0.4353*** (8.06)
Observations	11,251	11,251	11,251	11,251	11,251	11,251
Adjusted R-squared	0.003	0.295	0.157	0.003	0.458	0.243
Fixed Effects	Industry & Year	Industry & Year	Industry & Year	Firm & Year	Firm & Year	Firm & Year

^a See Appendix A for variable definitions.

^b *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. Standard errors are clustered by earnings announcement date.

Table 5
Closing Minute Earnings Response Coefficients

VARIABLES ^{a,b}	<u>Industry Fixed Effects</u>		<u>Firm Fixed Effects</u>	
	(1)	(2)	(3)	(4)
	<i>Closing Returns</i>	<i>Closing Returns</i>	<i>Closing Returns</i>	<i>Closing Returns</i>
<i>ClosingEA</i>	-0.0000 (-0.31)	-0.0001 (-0.65)	-0.0002 (-1.46)	-0.0003* (-1.82)
<i>SUE</i>	-0.0162*** (-2.73)	-0.0162*** (-2.76)	-0.0090 (-1.24)	-0.0094 (-1.35)
<i>ClosingEA x SUE</i>	0.0846*** (4.38)	0.0896*** (4.58)	0.0871*** (4.13)	0.0933*** (4.45)
<i>LiquidityTaking_HFT</i>		-0.0001 (-0.63)		0.0002 (0.90)
<i>ClosingEA x LiquidityTaking_HFT</i>		0.0001 (0.42)		0.0004 (1.00)
<i>SUE x LiquidityTaking_HFT</i>		-0.0024 (-0.14)		0.0012 (0.05)
<i>ClosingEA x SUE x LiquidityTaking_HFT</i>		0.1364** (2.25)		0.1907*** (2.66)
Controls	Yes	Yes	Yes	Yes
Observations	11,251	11,251	11,251	11,251
Adjusted R-squared	0.006	0.007	0.04	0.041
Fixed Effects	Industry & Year	Industry & Year	Firm & Year	Firm & Year

^a See Appendix A for variable definitions.

^b *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. Standard errors are clustered by earnings announcement date.

Table 6		
Overnight Returns		
	<u>Industry Fixed Effects</u>	<u>Firm Fixed Effects</u>
	(1)	(2)
VARIABLES ^{a,b}	<i>OvernightReturns</i>	<i>OvernightReturns</i>
<i>ClosingEA</i>	-0.0007 (-0.38)	-0.0014 (-0.44)
<i>SUE</i>	2.8920*** (20.11)	3.0719*** (18.84)
<i>ClosingEA x SUE</i>	-0.7106** (-2.30)	-0.5933* (-1.68)
<i>LagReturns</i>	0.0174*** (4.44)	0.0093** (2.25)
<i>Q4</i>	-0.0007 (-0.44)	-0.0021 (-1.25)
<i>Size</i>	0.0000 (0.06)	-0.0254*** (-7.51)
<i>BtM</i>	-0.0027 (-1.44)	-0.0041 (-0.77)
<i>ROA</i>	0.0159* (1.67)	0.0423** (2.15)
<i>AnalystFollowing</i>	0.0001 (0.48)	-0.0005 (-1.39)
<i>Dispersion</i>	0.0151* (1.95)	0.0136 (1.26)
<i>InstitutionalOwnership</i>	-0.0051 (-1.42)	-0.0059 (-0.63)
<i>InstitutionalConcentration</i>	-0.0022 (-0.20)	0.0408 (1.54)
<i>Constant</i>	-0.0117 (-1.58)	0.1862*** (7.14)
Observations	11,251	11,251
Adjusted R-squared	0.077	0.110
Fixed Effects	Industry & Year	Firm & Year

^a See Appendix A for variable definitions.

^b *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. Standard errors are clustered by earnings announcement date.

Table 7
Likelihood of Announcing at 4:00 PM

Panel A: Percentage of 4:00 PM announcements by year

	<u>2012</u>	<u>2013</u>	<u>2014</u>	<u>2015</u>	<u>Pre-Feb 4, 2014</u>	<u>Post-Feb 4, 2014</u>
Percentage of 4:00 PM announcements	0.060	0.056	0.049	0.038	0.058	0.044
Change from prior year		-0.004	-0.007*	0.011***		-0.014***
t-statistic		-0.55	-1.85	-3.60		-5.74

Table 7 Panel B

Panel B: Multivariate Likelihood of Announcing at 4:00 PM^{a,b}

	(1)	(3)
	<i>ClosingEA</i>	<i>ClosingEA</i>
<i>Post</i>	-0.0470*** (-5.31)	-0.0329*** (-4.44)
<i>SUE</i>	-1.2112** (-2.09)	-0.0170 (-0.04)
<i>LagReturns</i>	0.0231 (1.34)	0.0181 (1.36)
<i>LagVolatility</i>	0.0031 (0.39)	0.0032 (0.54)
<i>LagReturns</i>	-1.2356*** (-2.75)	-0.4533 (-1.00)
<i>Q4</i>	-0.5675 (-1.03)	0.2483 (0.34)
<i>Size</i>	-0.0223*** (-6.37)	-0.0183* (-1.69)
<i>BtM</i>	-0.0337*** (-3.17)	-0.0032 (-0.15)
<i>ROA</i>	0.0407 (0.90)	0.1200* (1.75)
<i>AnalystFollowing</i>	0.0007 (0.98)	0.0002 (0.12)
<i>Dispersion</i>	-0.0023 (-0.08)	-0.0734** (-2.20)
<i>InstitutionalOwnership</i>	-0.0232 (-1.27)	0.0661** (2.31)
<i>InstitutionalConcentration</i>	-0.0381 (-0.73)	-0.1474** (-2.03)
<i>Constant</i>	0.0207 (1.28)	0.1637*** (12.39)
Observations	11,251	11,251
Adjusted R-squared	0.04	0.556
Fixed Effects	Industry	Firm

^a See Appendix A for variable definitions.

^b *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. Standard errors are clustered by earnings announcement date.

Table 8
Cross-Sectional Tests on Investor Base

VARIABLES ^{a,b}	Predicted Sign	<u>Liquidity-Taking</u> <u>HFT</u>		<u>IO by</u> <u>Type</u>		<u>Institutional Ownership</u>	
		(1)	(2)	(3)	(4)	(5)	(6)
		Dependent Variable = <i>ClosingEA</i>					
<i>Post</i>	(-)	-0.0632*** (-5.82)	-0.0351*** (-4.33)	-0.0462*** (-5.01)	-0.0296*** (-3.97)	-0.0466*** (-5.11)	-0.0303*** (-4.07)
<i>Post x LiquidityTaking_HFT</i>	(-)	-0.0835*** (-2.77)	-0.0438* (-1.78)				
<i>Post x InstitutionalOwnership_DED</i>	(?)			0.1213 (1.43)	0.0391 (0.45)		
<i>Post x InstitutionalOwnership_QIX</i>	(?)			0.0080 (0.15)	-0.0410 (-1.03)		
<i>Post x InstitutionalOwnership_TRA</i>	(-)			-0.1625* (-1.76)	-0.1408** (-2.06)		
<i>Post x InstitutionalOwnership</i>	(-)					-0.0104 (-0.24)	-0.0574* (-1.89)
Main Effects		Yes	Yes	Yes	Yes	Yes	Yes
Controls		Yes	Yes	Yes	Yes	Yes	Yes
Observations		11,251	11,251	11,251	11,251	11,251	11,251
Adjusted R-squared		0.040	0.556	0.042	0.556	0.041	0.556
Fixed Effects		Industry	Firm	Industry	Firm	Industry	Firm

^a See Appendix A for variable definitions.

^b *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. Standard errors are clustered by earnings announcement date.

Table 9
Cross-Sectional Tests on Announcement Pricing Uncertainty

VARIABLES ^{a,b}	Predicted Sign	<u>Earnings Surprise</u>		<u>Analyst Dispersion</u>		<u>Intangibles Percent</u>	
		(1)	(2)	(3)	(4)	(5)	(6)
		Dependent Variable = <i>ClosingEA</i>					
<i>Post</i>	(-)	-0.0471*** (-5.33)	-0.0329*** (-4.42)	-0.0470*** (-5.32)	-0.0330*** (-4.46)	-0.0467*** (-5.30)	-0.0348*** (-4.65)
<i>Post x Earnings Surprise</i>	(?)	1.3648 (1.00)	0.1235 (0.12)				
<i>Post x Analyst Dispersion</i>	(-)			-0.0114 (-0.20)	-0.0785 (-1.64)		
<i>Post x Intangibles Percent</i>	(-)					0.0495 (1.31)	0.0381 (1.27)
Main Effects		Yes	Yes	Yes	Yes	Yes	Yes
Controls		Yes	Yes	Yes	Yes	Yes	Yes
Observations		11,251	11,251	11,251	11,251	11,251	11,251
Adjusted R-squared		0.040	0.556	0.040	0.556	0.041	0.556
Fixed Effects		Industry	Firm	Industry	Firm	Industry	Firm

^a See Appendix A for variable definitions.

^b *, **, and *** indicate statistical significance at 10%, 5%, and 1%, respectively. Standard errors are clustered by earnings announcement date.