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Weishao Wu
School of Management and Economics
University of Electronic Science and Technology of China

Wenchien Liu
Department of Finance
Chung Yuan Christian University

Sandy Suardi
School of Accounting, Economics and Finance
University of Wollongong

Yuanchen Chang*
Department of Finance
National Chenchi University

*Corresponding author: Department of Finance, National Chengchi University, No. 64, Sec. 2, ZhiNan Rd., Wenshan District, Taipei City 11605, Taiwan, ROC. Tel.: +886 02-29393091 x81102. E-mail address:yccchang@nccu.edu.tw.

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Yuanchen Chang*
Department of Finance
National Chenchi University

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Abstract

This paper demonstrates the profits earned by informed high frequency traders (HFTs) from two-second of advance peek into the Michigan Index of Consumer Sentiment (ICS), provided by Thomson Reuters to its elite customers. Using individual stocks in the NASDAQ dataset, we show how HFTs trade around ICS events. We find that liquidity demanders during two seconds of advance peek earn substantive profits, which are consistent with the notion that HFTs' informational advantages may increase adverse selection costs for other market participants. This evidence elucidates the debate on regulatory oversight and helps circumvent the potentially adverse effects from an advance peek into ICS.

JEL Classification: G12; G14; K22; D82

Key words: Informed trading; high frequency traders; advance peek; information efficiency; price discovery

* Corresponding author: Department of Finance, National Chengchi University, No. 64, Sec. 2, ZhiNan Rd., Wenshan District, Taipei City 11605, Taiwan, ROC. Tel.: +886 02-29393091 x81102. E-mail address: yccchang@nccu.edu.tw.

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Abstract

This paper demonstrates the profits earned by informed high frequency traders (HFTs) from two-second of advance peek into the Michigan Index of Consumer Sentiment (ICS), provided by Thomson Reuters to its elite customers. Using individual stocks in the NASDAQ dataset, we show how HFTs trade around ICS events. We find that liquidity demanders during two seconds of advance peek earn substantive profits, which are consistent with the notion that HFTs' informational advantages may increase adverse selection costs for other market participants. This evidence elucidates the debate on regulatory oversight and helps circumvent the potentially adverse effects from an advance peek into ICS.

1. Introduction

Informed trading is a longstanding issue that has been debated extensively. In the absence of market impediments, all investors should receive information pertinent to the value of a stock or index immediately and simultaneously. In practice, however, some agents receive the information before it is disclosed to the general public. The point of contention is that early-informed agents, when combined with an appropriate trading strategy, can generate substantial profits. In this paper we provide evidence for the existence of informed trading from two seconds of advance peek into the Michigan Index of Consumer Sentiment (ICS).

This study is motivated by a report published by the Wall Street Journal (WSJ), which suggested that certain investors, including many high-frequency traders, received the University of Michigan's consumer report two seconds before everyone else in 2013. Given that an early peek into the index, when combined with high frequency trading techniques, can result in windfall profits, the New York Attorney General in April, 2013 began scrutinizing whether the advance release to some customers violates the Martin Act, New York's securities law.[1] As part of an agreement with the N.Y. Attorney General's office, Thomson Reuters announced on July 8, 2013 that it was suspending its early release practice. The early release practice sheds new light on the profitability of high frequency informed traders who receive ICS news earlier.

The two-second early access to the index of consumer sentiment is a fleeting window of opportunity which is most likely to be exploited by fast speed traders who are equipped with the technology and they can benefit from this tiered information content. The literature surveyed by Menkveld (2016) noted the contentious role played by high frequency traders, notably HFTs and new trading venues are intricately linked to the extent that they have helped market participants migrate quickly to electronic trading, which, in turn, has yielded lower transaction costs and more volume. The

[1] Former Securities and Exchange Commission Chairman Harvey Pitt worried that there is both a fairness and a disclosure issue. "Thomson Reuters Gives Elite Traders Early Advantage", *CNBC* (http://www.cnbc.com/id/100809395).
The source of WSJ news is https://www.wsj.com/articles/SB10001424127887324682204578515963191421602

electronic market structure, which relies heavily on automation implies that market participants need to compete on information processing and trading, both of which HFTs are known to be advantaged by. Theory suggests that HFTs, as better informed agents, are as good as high frequency market makers in predicting signs of future market orders and hence provide greater market depth (Ait-Sahalia and Saglam, 2017). Their knowledge of fundamental value can lead low-private value agents to become more informed market makers, which improves market liquidity (Goettler, Parlour, and Rajan, 2009). There is also evidence suggesting that HFTs as faster-acting agents are bad. Empirical studies document that orders placed by fast traders reflect advance information (Kirilenko, Kyle, Samadi, and Tuzun, 2017; Brogaard, Hendershott, and Riordan, 2014; Hendershott and Riodan, 2013). However, this informational advantage may generate adverse selection costs for other market participants. Bernales (2014) finds that the result of a speed dispersion between high frequency traders and ordinary traders leads to less gains from trade being realized. Slow traders are effectively forced out of using limit orders due to the increased adverse selection risk. Baron, Brogaard, Hagströmer, and Kirilenko (2018) demonstrate that high frequency traders earn short-term profits on their market orders, at the expense of other market participants.

The combination of fast speed in trading and in information access by high frequency traders can be harmful and/or beneficial for the market. Bongaerts and Van Achter (2016) focus on high frequency market makers' price competition in a limit-order market and find that increased speed of contract rate leads to faster undercutting and therefore benefits liquidity. Nonetheless, if furthermore high frequency market makers have an informational advantage, then liquidity is reduced because of increased adverse selection risk for other trader market makers (Jovanovic and Menkveld, 2016). Biais, Foucault, and Moinas (2015) theoretically predict that the provision of high speed market connections permitting fast traders to obtain information before slow traders generates adverse selection and negative externalities. These can lead to overinvestment in fast trading technologies in equilibrium. Given HFTs' access to state-of-the-art information technology and the extensive role they play as liquidity providers in financial markets, the question whether tiered information disclosure when combined with fast trading technologies

imposes adverse selection costs to other traders and grants fast traders short-term profits is worth investigating empirically.

We focus our empirical investigation on the NASDAQ high frequency dataset because it explicitly identifies HFTs from non-HFTs. The dataset also identifies whether HFTs are supplying liquidity or demanding liquidity[2]. These two features give us a unique opportunity to provide direct evidence concerning the role of HFTs during two seconds of advance peek into the Michigan Index of Consumer Sentiment, compared to the contemporaneous work by Hu, Pan, and Wang (2017).[3] In addition, we study individual stocks as opposed to a single composite index, and by combining with the Nasdaq dataset it allows us to study how HFTs trade around these events. We show that informed trading by HFTs during the two-second advance peek is prevalent in our sample. Given the extremely short time window of two seconds to access this tiered information, it is likely that this information release will bring significant benefits to liquidity-demanding HFTs. On the assumption that liquidity-demanding HFTs have an informational advantage during the advance peek, we estimate their profit from exploiting the two-second window period prior to the ICS announcements. We assume that informed HFTs open their trading positions during the advance peek before closing them out two or several seconds later. The maximum cumulative profit of an informed liquidity-demanding HFT for 26 HFT firms is in the order of $2.5 million for individual stocks listed on NASDAQ and NYSE.[4] Furthermore, there is evidence of a

[2] By supplying liquidity, we mean the limit order standing on the order book that was hit by a marketable order (i.e., a market order or a more recent limit order taking the opposite side of the transaction).

[3] Hu et al. (2017) address the early peek advantage of the ICS and focus on the trading and price behavior in E-mini S&P 500 futures without differentiating HFTs from non-HFTs, and liquidity demanders from liquidity suppliers.

[4] This profit is computed based on extrapolating the profit made by HFTs from trading a stratified sample of 118 stocks, which is highly representative of both the NASDAQ and NYSE markets totaling over 7000 stocks. We have not considered other types of financial instruments like futures and composite indices, which are likely to increase the profit made by HFTs by manifold as a result of early peek advantages. Our computation of HFTs' profit amounting to $41,637, which arises from early peek advantage and computed from 118 stocks, is also believed to be a conservative estimate given that: (i) our profit calculation also includes HFTs who may not have access to an early peek and therefore could have opened their trade position wrongly or trade in the direction that contradicts the news in that two-second window period; (ii) there is misclassification of some HFTs as non-HFTs; (iii) the profit calculation includes only 118 sample stocks of which more than 97% of the profit comes from 40 large-size firms; and (iv) we have made the assumption that HFTs established their stock positions within one second after they had an early peek of the ICS.

first-mover advantage in that the earlier the informed traders exploit information obtained during the advance peek, the bigger their profit will be.

This study contributes to the existing literature in three important ways. First, the impact of HFT on market quality has attracted substantial interest in the past several years (Brogaard, 2010; Hendershott, Jones, and Menkveld, 2011; Hirschey, 2018; Angel, 2014; Brogaard, Hendershott, and Riordan, 2014; Goldstein, Kumar, and Graves, 2014; Jarnecic and Snape, 2014; Laughlin, Aguirre, and Grundfest, 2014; Scholtus, van Dijk, and Frijns, 2014; Aitken, Cumming, and Zhan, 2015; Aitken, Aspris, Foley, and Harris, 2018; O'Hara, 2015; Manahov, 2016). Parallel with this, a vibrant literature exists on trading activity around macroeconomic announcements (Ederington and Lee, 1993; Fleming and Remolona 1999; Flannery and Protopapadakis, 2001; Balduzzi, Elton, and Green, 2001; Andersen, Bollerslev, Diebold, and Vega, 2003; Erenburg, Kurov, and Lasser, 2006; Tetlock, 2010). Our paper stands at the intersection of the HFT and macroeconomic announcements literature, and examines the roles of HFT around the advance release of the University of Michigan's consumer report.

The second contribution relates to the contention of tiered information release as a form of insider trading, which could disadvantage retail and long-term investors. Past studies look at an informed trading period of a longer duration ranging from several minutes (Bernile, Hu, and Tang, 2016), to several hours (Chakravarty and McConnell, 1997, 1999; Fishe and Robe, 2004), to several days and months (Meulbroek, 1992; Cornell and Sirri, 1992; Seyhun, 1986, 1992; Inci, Lu, and Seyhun, 2010). Fishe and Robe (2004) study five stockbrokers acquiring information from Business Week's "Inside Wall Street" (IWS) column at least four hours before it is released to the public.[5] Our results provide stark contrast in the duration (two seconds versus four hours) for which information that moves the market is acquired before it becomes public. Previous insider trading literature focused more on the ability of corporate insiders to exploit non-public information content for their own advantage (Hirschey and Zaima, 1989; Seyhun, 1990; John and Lang, 1991; Lee, Mikkelson, and Partch, 1992; Irvine, Lipson, and Pucketti,

[5] Fishe and Robe (2004) state that the broker obtained information about the publicly traded firms "in the early afternoon on Thursdays, before the public release of portions of the magazine over news wire (at 5:15 p.m.) and electronic distribution on America Online (at 7:00 p.m.)" (pp. 466-467).

2007). In this paper the information content of insider trading is on ICS, which is released in a tiered fashion and is accessible by market participants for some fees. A concern of this practice is that along with colocation, this two-tiered access to information grants HFTs a time advantage in accessing market-moving information that allows for latency arbitrage.

While helping price discovery in the very near term, latency arbitrage by HFTs discourages fundamental analysis on the side of slow traders. Given that HFTs' trades are clearly oriented to the very short-term and their algorithmic trades are programmed to quickly react to immediate news, it remains doubtful whether algorithms are also modeled to absorb information on longer-term fundamentals. Moreover, HFTs are also generally known not to have a real interest in securities they trade, nor in their issuers. They mainly look at real-time market trends, information concerning transactions occurring in each market they trade, and order updates posted by other market participants, in order to predictively anticipate the market. As such, it has been argued that insider trading 2.0 may negatively affect price informativeness and real resource allocation in the long run (Balp and Strampelli, 2018).

Thirdly and finally, this paper contributes to the literature on what advantages are enjoyed by HFTs before public information releases. A growing literature on this subject studies how informed HFTs affect price discovery of stock prices before public news releases (Bernile et al., 2016; Kadan, Michaely, and Moulton, 2015; Rogers, Skinner, and Zechman, 2017; Lucca and Moench, 2015). Kadan et al. (2015) document the occurrence of information leakage before analyst recommendations are publicly announced. Rogers et al. (2017) discover that equity prices respond to the SEC filing news around 30 seconds before public posting. Lucca and Moench (2015) show there are large average excess returns on U.S. equities before scheduled meetings of the Federal Open Market Committee (FOMC). Our results complement these studies as we document the existence of large profits that are earned ahead of the release of the University of Michigan's consumer report. The nature of the information structure of ICS is also different from previous studies because we can identify the exact time when high frequency traders received material information through the selective disclosure process by Thomson Reuters.

The paper proceeds as follows. Section 2 describes the practice of an advance peek into ICS and discusses the testable hypotheses. Section 3 presents NASDAQ high frequency trade data and the classification of positive and negative ICS news. Section 4 provides empirical results. Section 5 provides some robustness analyses. Section 6 concludes with some policy implications.

2. Advance Peek into the Index of Consumer Sentiment and Testable Hypotheses

2.1 The History of Surveys on Consumer Sentiment and the Two-Second Advance Peek

The University of Michigan (UM) started conducting surveys of consumer sentiment in 1946. The Surveys of Consumers are influential in public policy and in business circles, providing a gauge of consumer anticipation of changes in the economic environment. One part of the surveys, the Index of Consumer Expectations, is an official component of the U.S. Index of Leading Economic Indicators, which is a key element for understanding and forecasting changes in the national economy. The UM signed an agreement with Thomson Reuters in 2006, which gave the international news organization the exclusive right to distribute the highly regarded surveys of consumers. The survey was renamed the Thomson Reuters/University of Michigan Surveys of Consumers. Under this agreement, effective January 1, 2007, Thomson Reuters has the exclusive right to distribute the headline survey index numbers through its news and media services. Thomson Reuters also provides this data exclusively to more elite customers, who subscribe to its high-speed data feed, to receive the information at 9:54:58 (i.e., two seconds) prior to the data release to Thomson Reuters' other clients.[6] In exchange for exclusive access to the data, the contract stipulates that Thomson Reuters pays the University of Michigan $1 million per year, in addition to a "contingent fee" that is based on the revenue generated by Thomson Reuters.

It was not until June 12, 2013 that this two-second advance peek practice caught the attention of the media and was reported by CNBC and the Wall Street Journal, respectively. Both news reports highlighted the instantaneous response of the market when Thomson Reuters transmitted the data to its elite group of traders on May 17, 2013. Such anecdotal evidence is indicative of the work of high frequency traders who are likely to have access to the two-second advance release of Thomson Reuters'

[6] See http://www.cnbc.com/id/100809395.

consumer survey data. Since July 2013, Thomson Reuters has suspended the two-second early release of its ICS report to their elite subscribers at the behest of the New York Attorney General. The New York Attorney General is investigating whether this tiered system constitutes a violation of insider trading regulations, despite UM spokesperson Rick Fitzgerald maintaining that the UM's arrangement with Thomson Reuters complied with regulations and that the index is produced with private funds.

2.2 Empirical Hypotheses

2.2.1 Trading Characteristics of Informed HFTs

We hypothesize that other things being equal, informed HFTs will trade in the direction of stock price movement as predicted by ICS news in the two-second advance peek. These predictions are well substantiated by the literature on HFTs' trading behavior and characteristics. The model of Foucault, Hombert, and Rosu (2016) predicts that informed HFTs are prone to trade aggressively when they have faster access to news than other traders. Using a dynamic version of Kyle's (1985) model that incorporates new information about the payoff of a risky security, Foucault et al. (2016) demonstrate that the speed advantage to accessing news affects a trader's optimal strategy insofar as it affects the forecast of the asset payoff. HFTs are known to have speed advantage through their use of computer algorithms and by placing their computers in stock exchange data centers so they can trade faster. The two-second advance peek provides not only informational advantage, but further enhances the speed trading advantage that HFTs already possess over ordinary traders. It is important to recognize that in the two-second window when ICS is released, this tiered information provides HFTs with the ability to predict stock price movements better. The early release of information facilitates HFTs to trade in the direction of stock price movements ahead of other investors. We therefore hypothesize HFTs trade in the direction of stock price movements as predicted by ICS news in the two-second advance peek.

Hypothesis 1 (*H1*): Informed HFTs with early access to the Thomson Reuters/UM consumer sentiment survey tend to trade aggressively, and their trade imbalance increases (decreases) with positive (negative) ICS news.

2.2.2 Informed HFTs and Price Discovery

It is well recognized that fast trading technologies accelerate access to value-relevant information for an asset through recent transaction prices and quote changes for this asset. The theoretical model of Ait-Sahalia and Saglam (2017) analyzes an informed high frequency market maker in a continuous-time dynamic inventory model in which they find that the liquidity improves if the informed high frequency market maker is better able to predict the sign of future market orders. Goettler, Parlour, and Rajan (2009) also find liquidity improvement when market makers become more informed about fundamental value. The ICS tiered announcements which operate in conjunction with fast trading technologies of high frequency traders will further enhance relevant-value information for an asset. In the presence of HFTs who are quick to process public information, this is most likely to influence market consensus about the value of a stock. When unexpected positive (negative) ICS news is released, stock prices are predicted to rise (fall). Informed HFTs who process the information in ICS announcements during an advance peek will trade in the anticipated direction of stock price movements; as such we hypothesize that informed HFTs' trade imbalance in the advance peek predicts future price changes or future stock returns.

Hypothesis 2 (*H2*): Informed HFTs with access to the two-second advance peek into ICS display large trade imbalances, which have predictive power on future returns over a short-term horizon.

2.2.3 Informed HFTs' Profits

Biais, Foucault, and Moinas (2015) show that financial institutions can decide to become fast traders because they fear obtaining low profits if they remain slow and so missing out on substantial financial gains. Fast traders in their model are traders who invest in fast trading technologies that will improve traders' ability to find attractive quotes and acquire advance information about asset payoffs. In this sense, fast traders in their model are akin to informed HFTs who have access to this tiered information. Additionally, theory also predicts that HFTs exploit their speed advantage by trading with less informed traders (Hirshleifer, Subrahmanyam, and Titman, 1994; Brunnermeier, 2005; Foucault et al., 2016). Hirshleifer et al. (1994) show that in a partially revealing rational expectations equilibrium, traders with early access to information trade aggressively in the initial period. Their model predicts that early

informed investors appear to be short-term profit takers. In the context of the two-second advance peek, we hypothesize informed HFTs are able to make substantially larger profits.

Hypothesis 3 (*H3*): Informed HFTs can take advantage of the early release of ICS news and generate substantial short-term positive profits.

3. Data and News Classification

3.1 The Data

The database consists of 120 stocks listed on the NASDAQ and New York Stock Exchange (NYSE) from January 1, 2008 to December 31, 2009. NASDAQ categorizes market participants as a high-frequency trading firm or non-high frequency trading firm, which allows us to identify investor types. The dataset also identifies what type of traders is supplying liquidity and demanding liquidity. CNBC reported that Thomson Reuters began to permit an elite group of clients to receive ICS information two seconds prior to the data release to other clients in September, 2009. We divide our total sample into pre- and post-September, 2009 samples and find that the practice of this advance peek is prevalent prior to September, 2009.[7] Our results indicate that the two-second advance peek on ICS may have occurred before January 2008. These results are consistent with the findings of Hu et al. (2017), who show that Reuters started to distribute ICS in multiple tiers sometime in 2007. It is noteworthy that the sample period available for the NASDAQ data coincides with the practice of ICS early release. Thus for a "treatment effect" analysis to take place over a longer time horizon requires the use of a different dataset like the S&P 500 exchange traded funds (ETFs) data, which is discussed in section 5 under robustness analysis. Nonetheless, the ETFs data, unlike the NASDAQ data, do not differentiate the HFTs from non-HFTs.

All trades are time-stamped to the millisecond, and the demanders and suppliers of liquidity are identified either as a high frequency trader (HFT) or non-high frequency trader (non-HFT). This is the

[7] Results based on the data for the post-September 2009 sample are not reported for brevity, but they are available from the author upon request. By and large, we find the effects of ICS early release in the post-September 2009 sample on return and trade dynamics are equally as strong as, if not stronger than, in the pre-September 2009 sample.

advantage of using the NASDAQ HFT data because each trader's status is explicitly provided. NASDAQ uses its knowledge of its customers to categorize whether a firm is a HFT. Although the data identify some HFTs, they suffer from a drawback in that not all HFTs are identified (Brogaard et al., 2014). Some large integrated firms that function as brokers for customers and are involved in proprietary lower-frequency trading strategies are not included in the data. In addition, HFTs that direct their orders through these large integrated firms are also not included in the sample. The 26 HFT firms in the NASDAQ data can be regarded as independent proprietary trading firms.[8]

The data also provide the following information: the NASDAQ trading symbol for a stock, the date and time for which trading occurred, the number of shares traded and the associated price, and whether the trade was buyer-initiated or seller-initiated. It also identifies type of traders who are involved in the transaction, denoted by H or N. The first (second) letter denotes the liquidity-demanding (supplying) participant in a transaction. Accordingly, a transaction can fall into one of four trading type combinations. The HH (HN) combination denotes a transaction in which a HFT demands liquidity and another HFT (non-HFT) supplies that liquidity. The NN (NH) combination denotes a transaction in which a non-HFT demands liquidity and another non-HFT (HFT) supplies that liquidity. The remainder of the paper denotes HFT liquidity-demanding trades as HFT^D (HH plus HN). We use this notation for HFT trading volume (buy volume plus sell volume) and HFT trade imbalance. The HFT trade imbalance is defined as the net trading volume, which is the HFT buyer-initiated volume minus HFT seller-initiated volume. This definition is consistent with Hirschey's (2018) measure of net marketable buying imbalance.

Along with the NASDAQ HFT data, we also use supplementary data to retrieve the national best bid and best offer (NBBO) from the NYSE Trade and Quoting (TAQ) database and the NASDAQ best bid and best offer (NASDAQ BBO). The NBBO data provide best prices that prevail in all markets over 2008 and 2009, thus permitting a study on market-wide price discovery. NASDAQ BBO, however, only

[8] These 26 firms represent a significant amount of trading activity that NASDAQ believes characterizes them as HFTs.

provides the best available prices on NASDAQ for the first week of every quarter in 2008 and 2009, and thus this dataset is less informative than NBBO. We use the NBBO data to compute stock returns. Following Brogaard et al. (2014), we categorize stocks into three market capitalization groups - large, medium and small. Market capitalization data are based on the end-of-2009 data obtained from S&P Compustat. We drop two stocks, Boise Inc. (BZ) and MAKO Surgical Corp. (MAKO), because they do not appear in the TAQ database for part of our sample period.

3.2 Classification of Early Release of the Survey Data as Positive and Negative News

Our hypotheses focus on the information content associated with the early release of Thomson Reuters/UM survey data on the behavior of HFTs' trading activities. To test these hypotheses, we measure news surprises of the ICS announcements as the difference between market expectations and the announced values of ICS. This measure is consistent with the convention of computing news surprises in the literature of macroeconomic announcements.[9] To establish whether there are asymmetric effects, we classify an early release of survey data as positive or negative news, using the announcement surprises based on the Thomson Reuters survey of economists. Every two weeks Thomson Reuters contacts a cross-section of economists for the purpose of collecting their forecasts of the consumer sentiment index. The median of collected forecasts serves as an estimate for the market expectations of the upcoming releases. The unexpected component for the survey of consumer data is estimated by computing the difference between the early released value for the Thomson Reuters/UM Index of Consumer Sentiment and the median forecast from the Thomson Reuters Survey of Economists. When the value for the ICS is higher (lower) than the median forecast from the Thomson Reuters Survey of Economists, it is regarded as positive (negative) news.

4. Empirical Results

4.1 Preliminary Data Analysis

Figure 1 shows the intraday patterns of trading volume (Figures 1a and 1b), trade imbalance (Figures 1c and 1d), and stock returns (Figures 1e and 1f) on days with and without ICS announcements

[9] See, for example, Adams, McQueen, and Wood (2004) and Boyd, Hu, and Jagannathan (2005).

for the first sample. In each figure, the solid (dotted) line depicts characteristics of the variable in question on the ICS announcement (non-ICS announcement) days, which are the days when early releases of the consumer surveys are (not) reported.[10] The non-ICS announcement days are used as a control sample to compare and contrast the effect of two-second advance peeks on trading characteristics.

- Figure 1 about here -

The trading volume in Figures 1a and 1b, which is measured by the number of shares scaled by daily average one-second volume, displays a significant jump at 9:54:58, or two seconds prior to the release of the consumer survey data to non-elite subscriber clients for positive and negative ICS reports. In fact, the trading volume at 9:54:58 is higher for bad news than that for good news, suggesting that HFTs may have more incentive to exploit the two-second early release of negative consumer sentiment news to their advantage. Given that part of the sample falls in the period during the global financial crisis when traders were more cautious in a bear market, it is not surprising that we find: firstly, the response to trading volume is higher; and secondly, reversal to the pseudo-event level is faster for bad news than for good news during the early release of ICS.

Figures 1c and 1d depict the response of trade imbalance, which is defined as the per second cumulative difference between buyer-initiated volume and seller-initiated volume to the advance peek on ICS. The figure shows a sharp hike (drop) with buy (sell) orders significantly exceeding sell (buy) orders at 9:54:58. In contrast, no trade imbalance jump is observed on non-ICS announcement days. The response of trade imbalance to the early release of consumer survey news suggests that traders with access to this information are able to exploit it to their advantage by placing greater buy (sell) orders in anticipation of market reaction to positive (negative) news.

Figures 1e and 1f show the response of stock return to the early release of consumer survey data. Stock return is computed as the first difference of the logarithmic price across one second. It can be seen

[10] Preliminary (Final) announcements occur on the second (last) Fridays of the month. Non-ICS announcement days are the same day when no announcements are made. However, in the event of a holiday on these non-announcement days, we use the prior day.

that returns jumped (dropped) to an all high (low) of 1.75% (-1.2%) at two seconds prior to the consumer survey data release. The significant burst in trading activities reflects the nature of consumer survey news.

To summarize, the early release of consumer survey data has significant effects on trading activity and stock returns; traders behave very differently on ICS announcement days compared to non-ICS announcement days. Furthermore, the persistence of the responses in trade volume, and trade imbalance is contingent on the news about whether the consumer survey is positive or negative. There is also evidence that the two-second early release of consumer survey data leads to some degree of price discovery as reflected by the sharp difference in the level of stock returns at 9:54:58. a.m.

For the purpose of robustness, instead of comparing ICS days to non-announcement days, we also compare results to a control sample with announcement days on new home sales, which no early peek access was sold. These results, provided in Figure A1 in the Appendix, indicate there is no abnormal trading activity two-second before the news release.[11]

4.2 Return and Trade Characteristics around ICS Advance Peek

Table 1 reports return and trade characteristics from January 1, 2008 to August 31, 2009 around ICS advance peek. We compute the one-second interval trade volume, trade imbalance and stock return before and after ICS announcements at 9:55 a.m.

ICS announcement days are ICS announcement Fridays and non-ICS announcement days are also Fridays but with no ICS announcements made. HFT^D and non-HFT^D denote liquidity demanders of (non-)

[11] In Figure A1 the observed spikes in trading volume (Panel a) for positive news of new home sales, trade imbalance (Panel c) and returns (Panel e) are consistent with the view that there is evidence of pre-announcement drift on stocks for certain announcements (see Kurov et al., 2017). Although these spikes are observed in a few seconds prior to the actual announcement of new home sales news, it is visible that the magnitude of the spike is never as large as the jump which occurs on the actual time (or one second lag) of the announcement. To determine whether there is any statistically significant result in the difference of trading volume, trade imbalance and returns in the time periods 9:59:58-10:00:00 and 10:00:00-10:00:02, we compute the mean difference test under the null that the mean difference is zero. To conserve space, the results are not presented here but are available from the authors upon request. The test generally rejects the equality in the return, volume and trade imbalance in the two periods, and the magnitude of return, volume and trade imbalance are in the right order (i.e. it is larger in 10:00:00-10:00:02 compared to that in 9:59:58-10:00:00). Comparing these results with the results in Table 1 for the ICS news, it can be seen that the magnitude of return, volume and trade imbalance is larger during the early release of ICS news compared to post-release of news, a pattern which differs from those concerning new home sales news. Overall these results imply that the two seconds early release of ICS news did exert an impact on trading characteristics to the extent that the magnitude of its effect is larger than that of post-announcement.

high frequency traders. When the value for the ICS is higher (lower) than the median forecast from the Thomson Reuters Survey of Economists, it is regarded as positive (negative) consumer sentiment news.

- Table 1 about here -

Panel A of Table 1 reports the results for ICS announcement days and panel B for non-ICS announcement days. In Columns (4) and (7) of Table 1, we report mean difference tests on returns, trade volume and trade imbalance for negative and positive consumer sentiment news. We find that returns are larger in magnitude during the early peek period (9:54:58 to 9:55:00). The differences before and after ICS announcements at 9:55 a.m. are statistically significant. Similar to the results of returns, we also find abnormally high trade volume and trade imbalance for liquidity demanders of HFT in the early peek period. The difference in trading volume is statistically significant between 9:54:58-9:55:00 and 9:55:00-9:55:02 for negative news and for HFT^D. However, this is not statistically significant for positive news. In the case of trade imbalance, we observe that the trade imbalance for both HFT^D and non-HFT^D are larger in the early peek. While it appears that both HFTs and non-HFTs appear to respond in the same way to early peek, it is important to recognize that this observation is subject to two caveats: (a) some HFTs are classified as non-HFTs with no clear and obvious way of identifying them within the non-HFTs classification, and (b) the number of non-HFTs far outweighs the 26 HFTs. These results suggest that early informed traders utilize information about ICS negative news and place higher marketable sell orders than marketable buy orders, and the reverse is true for ICS positive news.

Taken together, it can be seen from Table 1 that informed traders during the two-second advance peek are able to utilize information from early access to ICS announcements to influence market prices and trade imbalances. The results also show that the average trade imbalance has an opposite sign for positive and negative consumer sentiment news, which indicate that HFT^D buy on positive- and sell on negative ICS news.

Panel B of Table 1 reports results for non-ICS announcement days. We find that return, volume, and trade imbalance before and after ICS announcements at 9:55 a.m. are similar in magnitude. These

results support Hypothesis 1—informed HFTs (in particular, liquidity-demanding HFTs) trade aggressively, which is manifested through higher trading volume and trade imbalance in the two seconds prior to the ICS releases. In addition, stock returns are positively and negatively higher for both positive- and negative ICS news.

Finally, in unreported results, we compare trade characteristics of HFTs and non-HFTs for the NASDAQ data during the period January 2008 – September 2009 by executing the difference-in-difference tests in two stages. In the first stage, we compute the difference in trade volume, trade imbalance and frequency for the period (9:54:58-9:55:00) and (9:55:00-9:55:02). In the second stage, we test the difference in trade volume, trade imbalance and frequency between the HFT^D and non-HFT^D. The results seemingly fail to support the prediction that trade volume and frequency of HFT^D who exploited ICS early release would display higher order of magnitude for positive news relative to those of non-HFT^D. The results appear to hold only in the case of negative consumer sentiment news. In addition, the trade imbalance results do not suggest that there is any statistically significant difference between HFT^D and non-HFT^D.

Nevertheless, we would interpret these results with caution given that there are differences in the number of trading accounts of HFT^D and non-HFT^D. There are 26 firms that are classified as HFT^D but the number of non-HFT^D including all other trading accounts in the market - is significantly larger than 26. Consequently, the effect of ICS early release on the order of the magnitude of the trade volume, trade imbalance and frequency may be masked by trading activity that is closely associated with the larger number of non-HFT^D. Additionally, the results can be biased by an inherent limitation in the NASDAQ data, i.e. not all HFT are identified (Brogaard et al. 2014). Consequently, the apparent larger order of magnitude in the variable associated with non-HFT^D can be attributed to some HFT^D being classified as non-HFT^D. In principle, we cannot interpret the prima facie mixed evidence in the difference of trade characteristics between HFT^D and non-HFT^D. For these reasons, we do not report the results but they are available from the authors upon request.

4.3 Determinants of Trade Imbalance Dynamics Surrounding ICS Announcements

To examine the determinants of trade imbalance dynamics surrounding ICS announcements, we modify Fishe and Robe's (2004) empirical specifications to perform the following pooled ordinary least squares (OLS) regressions using one-second data over the five-minute intervals before and after ICS announcements at 9:55 a.m.;[12] and the standard errors are corrected for heteroscedasticity according to White (1980):

$$TI\_HFT_t^D = \text{Intercept} + \beta_1 EarlyPeek + \beta_2 Release + \beta_3 Final + \beta_4 Large + \beta_5 Surprise + \varepsilon_1 \quad (1)$$

In equation (1), the dependent variable $TI\_HFT_t^D$ ($TI\_nonHFT_t^D$) denotes per second trade imbalance of HFT^D (non-HFT^D). Here, the dependent variable is replaced with $TI\_nonHFT_t^D$ for non-HFTs. Each type of trader's trade imbalance is standardized to have a mean of zero and a standard deviation of one for each stock on each announcement day. The differences in trade imbalances between early peek and the release of ICS are examined over a number of factors. Regression (1) analyses trade imbalance differences between early peek and ICS release while controlling for the market capitalization of stocks, the type of ICS announcements (mid-month or end-of-month) and the magnitude of news surprises. In all regressions, the time interval dummy variables, *EarlyPeek* and *Release* denote the two-second advance peek duration (9:54:58 through 9:54:59) and two-second interval after a broader release (9:55:00 through 9:55:01), respectively. The results of regression (1) are reported in Panel A of Table 2.

Panel B reports the regression results, which consider the presence of trade imbalance between early peek and ICS release for stocks with different market capitalization. Here, *Large* is a dummy variable for large market capitalization stocks, such that it takes the value of 1 if the stock is large cap and 0 otherwise. Panel C reports the regression results for trade imbalance differences between early peek and ICS release for the timing of the ICS announcements. Here, *Final* is a dummy variable that equals one for end-of-month ICS announcements and zero for middle-of-month ICS announcements. The *Final* dummy variable determines whether the mid-month or final-month ICS announcements are more informative in influencing (non-)HFT's trade imbalances. Panel D reports the results of the regression which studies the

[12] Our results are not sensitive to the choices of time intervals. We perform the analysis with 10-minute and 15-minute time intervals and the results remain qualitatively unchanged.

effect of heterogeneity in surprises on HFT's trade imbalances. Surprise is measured by the absolute difference between the actual and expected ICS. Panel E shows the regression results which allow for interaction terms of the *EarlyPeek* and *Release* dummies and the other covariates.

- Table 2 about here -

Table 2 reports the results of the determinants of per second trade imbalance of HFT^D and non-HFT^D in the five-minute intervals before and after ICS announcements at 9:55 a.m. We find that the coefficients of *EarlyPeek* are statistically significant in all cases, implying that the two-second advance peek has an impact on trade imbalance. The baseline regression results in Panel A show that negative (positive) news decreases (increases) trade imbalance, which supports our finding in Table 1 that liquidity-demanding high frequency traders sell (buy) more with the early release of negative (positive) ICS news. The coefficient of *EarlyPeek* for the non-HFT^D regression is also statistically significant albeit the magnitude of the coefficient is half that of HFT^D regression. As previously explained, this statistical significance can be caused by an inherent limitation in the NASDAQ data. That is, not all HFTs are identified and some HFT^D are being classified as non-HFT^D. Following the tiered announcements of ICS, news about consumer sentiment continues to exert an influence on trade imbalance for two seconds. However, the degree of responsiveness of trade imbalance to news of ICS at this point is lower than that of the advance peek (9:54:58 through 9:54:59) as judged by the magnitude of the coefficients.

Panel B shows that the coefficients of the interactive term between *EarlyPeek* and large cap stocks are statistically significant and have the same sign like those of *EarlyPeek* and *Release* suggesting that trade imbalances of stocks with large market capitalization change more appreciably than stocks with small or medium market capitalization. This is not surprising because HFTs have a propensity to trade in stocks with larger market capitalization, which are more liquid. Panel C shows that the coefficients of the interactive dummy variables *EarlyPeek* and *Final,* and those of *Release* and *Final,* are statistically significant and have the opposite sign from those of *EarlyPeek* and *Release*. These results suggest that final reports of ICS news are less informative than mid-month reports because the former tends to have a

smaller effect on trade imbalance. This outcome is not surprising because information about the state of the economy is contained in the mid-month ICS report, while the final report tends to reflect minor data revisions of the mid-month ICS report. Panel D shows the coefficients of the interactive term between *EarlyPeek* and *Surprise*, and the interactive term between *Release* and *Surprise* are by and large statistically significant, suggesting that large surprises in the news exert a bigger effect on trade imbalances of traders. Additionally, the effect of large news surprises on trade imbalance is not only more appreciable during tiered information release but particularly so with HFT^D. Panel E, which reports the regression results that incorporate all of the interaction terms considered in Panels B to D, shows that the results are largely robust when these covariates are considered simultaneously.

4.4 The Price Discovery Process of Trading on Advance Peek Information

To study the price discovery process of trading on advance peek information, we perform the following pooled OLS regressions using one-second data over the five-minute intervals before and after ICS announcements at 9:55 a.m.; and the standard errors are corrected for heteroscedasticity according to White (1980):

$$r_t = \text{Intercept} + \sum_{i=1}^{5} \beta_i TI\_HFT_{t-i}^{D} + \sum_{i=1}^{5} \theta_i TI\_NonHFT_{t-i}^{D} + \varepsilon \qquad (2)$$

$$r_t = \text{Intercept} + \sum_{i=1}^{5} \beta_i TI\_HFT_{t-i}^{D} + \sum_{i=1}^{5} \delta_i Release \times TI\_HFT_{t-i}^{D} + \sum_{i=1}^{5} \theta_i TI\_NonHFT_{t-i}^{D} + \sum_{i=1}^{5} \gamma_i Release \times TI\_NonHFT_{t-i}^{D} + \varepsilon \qquad (3)$$

The purpose of this regression is to examine whether trade imbalances, particularly during the two-second duration of the advance peek, have predictive power on stock returns. Here, the dependent variable of both regressions (2) and (3), $r_t$denotes the one-second interval stock returns. The explanatory variables comprise $TI\_HFT_{t-i}^{D}$ and $TI\_NonHFT_{t-i}^{D}$, which denote the trade imbalance of HFT^D and non-HFT^D, respectively. The variable *Release* is a dummy variable defined as one at event time 9:55:00 a.m. and one second after the ICS announcement, and zero otherwise. This dummy variable interacts with various

lagged trade imbalances of HFT^D and non-HFT^D to capture the effect of trade imbalance on stock returns surrounding the timing of the ICS announcement, focusing particularly in the two seconds prior to the actual announcement time of 9:55:00 a.m. Our interest is in the coefficients of the interactive dummy variable between *D* and the lagged trade imbalances of *t-2* and *t-3*, which can be interpreted as the information that is contained in ICS announcements when released two seconds before 9:55:00 a.m. Regression (2), unlike regression (3), does not include the interaction term between the dummy variable and the various lagged trade imbalances of HFT^D and non-HFT^D. In effect, regression (2) seeks to validate the predictive power of current and past trade imbalances of HFT^D and non-HFT^D on current stock returns unconditional on the timing of the ICS announcement.

It is important to exploit the value of the cross-section of stocks. It is unlikely that all stocks have similar levels of HFT and by splitting stocks according to their market capitalization it may reveal any difference in the impact of HFT vs. non-HFT trade imbalance on stock returns. To this end, we perform regression (3) for each category of stocks: stocks with large, medium and small market capitalization. Finally, we test whether the impact of HFT vs. non-HFT trade imbalance on stock returns is different across heterogeneity in the surprise levels associated with ICS early peek. Surprise is defined as the absolute difference between actual and expected ICS. The idea is that when new information is "truly" permeating the market or when there is high/large surprise in the ICS announcements, there may be a stronger price discovery process associated with early peek.

- Table 3 about here -

Table 3 shows the results of regressions of one-second interval stock returns on trade imbalance for transaction data in five-minute intervals before and after ICS announcements. It can be seen in Model 1 (i.e. regression 2) that for both negative and positive consumer sentiment news, current and past trade imbalances of both HFT^Ds and non-HFT^Ds have predictive power on current stock returns. Model 2 (i.e. regression 3) includes interactive variables between the dummy variable and lagged trade imbalances. It is interesting to note that the coefficients of the interactive dummy variable *Release* with trade imbalance

of liquidity-demanding HFTs are statistically significant for the time period *t* until *t-3*. The interactive dummy variable between *Release* and the lagged trade imbalances of *t-2* and *t-3* can be interpreted as the information that is contained in ICS announcements when released two seconds before 9:55:00 a.m. The statistically significant and positive coefficients of these variables suggest that the trade imbalances two seconds before the ICS announcements contain information that strongly predicts current stock returns. For example, for ICS positive news released at 9:54:58 a.m. and 9:54:59 a.m., informed HFTs incorporate this information to formulate the direction of their trade, which gives rise to greater trade imbalances. In this situation, they will buy in anticipation of a further rise in stock prices when ICS news is announced at 9:55:00 a.m. The increase in demand for stocks leads to greater trade imbalances, which in turn leads to an increase in stock returns. The impact on returns due to an increase in trade imbalance is positive during the advance peek, implying that informed HFTs stand to gain from higher stock returns as a result of early access to ICS news. The significance in the coefficient of the interactive terms for the periods *t-2* and *t-3* is observed only for HFT^D, suggesting that it is the increase in trade imbalance of liquidity-demanding HFTs that facilitates the price discovery process. Taken together, our results clearly support Hypothesis 2.[13]

- Tables 4 and 5 about here -

Table 4 shows the results of regressions of one-second interval stock returns on trade imbalance for transaction data in five-minute intervals before and after ICS announcements but separated by stocks market capitalization. Consistent with the results shown in Table 3, we find that it is the increase in trade imbalance of liquidity-demanding HFTs for large and medium caps that facilitates the price discovery process. Irrespective of the sign of news, in the first or two seconds early release of ICS there is evidence to suggest that the trade imbalance of HFT^D has a statistically significant impact on stock returns for large and medium cap stocks. As well, there is evidence to suggest that with a high level of surprise in the ICS

[13] Our results remain qualitatively unchanged and are robust even with the inclusion of a dummy variable which controls for the presence of no price changes in the dataset. In addition, using trading volume as weights and running weighted least square regressions yield qualitatively similar results.

news, the tiered ICS release gives rise to a statistically significant effect of the trade imbalance of HFT^D on stock returns (see Table 5). This finding is consistent with the intuition that when new information is "truly" permeating the market, the price discovery process is observed to be stronger with early peek.

4.5 Profits of Informed HFT^D from Trading on Advance Peek Information

Table 6 reports aggregate profits across all stocks on announcement days. We analyze high frequency transaction data on ICS announcement days from January 1, 2008 to August 31, 2009. We assume that traders buy or sell during the two-second advance peek before 9:55:00 a.m. This could be two seconds prior to 9:55:00 a.m. denoted by "9:54:58", one second prior denoted by "9:54:59". For a conservative estimate of the profits earned by informed traders who utilize pre-release ICS news during the early peek, we consider both scenarios: (a) traders' open position is consistent with the sign of news; buy (sell) for positive (negative) news; and (b) traders' open position contradicts the sign of news. We further assume that these positions are closed at different points in time, measured in seconds, after the ICS announcements at 9:55:00 a.m. The settlement price for closing out a position is represented by the volume-weighted average price at that time. If no price exists at that time, then we use the last observable price for that stock. Finally, we compute profits with respect to the duration of traders' open-close position.

- Table 6 about here -

It can be seen from Panel A in Table 6 that liquidity-demanding informed traders who exploit ICS announcements two seconds before they are announced make higher profit than those who exploit the information one second later. When HFT^D close their position between 9:55:00 and 9:55:05 a.m., the difference in profits is about $30,000. It can be inferred that early access to ICS, coupled with a first-mover advantage, can give rise to large profits. Our results also suggest that informed HFT^D will earn the most if they close out their position four seconds after the ICS announcement (i.e. 9:55:04 a.m.). Comparing the profits earned by HFT^D and non-HFT^D who opened their position two seconds prior to ICS announcements, the difference in profit ranges between $5,000 and $5,500 in the first 5 seconds of

closing out a position, thus suggesting that informed HFT^D, in general, can make more profit than non-HFT^D. This quantum of profit differences may appear economically insignificant at first sight. Nevertheless, it is important to emphasize that this conservative profit estimate is in fact economically significant for a number of reasons. Firstly, the profit is computed based on trades which were executed in the anticipated direction of market movements based on early peek advantages minus losses of HFT^D who may not have access to an early peek, and therefore they have traded against market movements. Should the profits be restricted to HFT^Ds who benefitted from the early peek, the difference in profit between HFT^D and non- HFT^D would be substantially larger. Secondly, close to 97% of the profit made is attributed to trades in stocks with large market capitalization.

While our profit is derived from trades in individual company stocks, it provides a useful indicator for the sheer size of potential profit made by a HFT^D who trades in composite index like the ETFs and E-mini S&P 500 futures. In this regard our results complement the findings of Hu, Pan, and Wang (2017) who investigated the impact of early peek advantage on price discovery of the E-mini S&P500 futures but did not consider the implications on equity and profits between HFTs and non-HFTs. Thirdly, the profit is computed on the basis of a small sample of stocks (i.e. 118 stocks) considered in the NASDAQ data, which are constructed using stratified sampling from both the NASDAQ and NYSE. In other words, while the sample of stocks may be small they are a good representation of the wider NASDAQ and NYSE markets, which comprise more than 7,000 stocks. Taking a simple extrapolation of the potential profit made by 26 HFTs who trade in the stocks on both markets would amount to profit larger than $2 million. Fourthly, HFTs also trade in derivatives and ETFs other than stocks, and it is likely that by having access to the early peek and trading in these financial instruments there are greater profit-making opportunities, which are not reflected in our conservative profits estimate. Finally, for the NASDAQ data which we employed, some HFTs are identified as non-HFTs, which means our results tend to underestimate the HFTs' profit and overestimate the non-HFTs' profit. In sum, our results support Hypothesis 3 that informed HFTs' trade imbalance arising from the advance peek into ICS generates substantial positive profits.

We also test the difference in mean profits between HFT and non-HFT traders averaged across stocks for liquidity demanding and liquidity supplying traders. To conserve space, the results which are not reported here but are available from the authors upon request, show that these differences are by and large statistically significant for the open position of 9:54:59 and across all periods of close position, except for 9:55:30 and 9:56:00. We also consider the open position for HFTs in the first two seconds prior to the official announcement time and their trading volume for each second starting from 9:55:00 to 9:55:05. In the case of negative ICS news the open position amounts to 883,211 shares. Judging by their trading volume it takes approximately four seconds before they are able to close their position. This result is consistent with expectations and suggests that their profits are realizable.[14]

5. Robustness analyses: Difference-in-difference analysis for S&P 500 ETFs

So far the foregoing analysis is limited by the paucity of NASDAQ data that are available only for the period January 2008 – September 2009, which comprises 20 months. Since ICS is announced on a monthly basis, it should provide 20 announcement days during the sample period and a total of 40 announcement days when taking into consideration the preliminary (middle of the month) and revised (last Friday of the month) announcement. To validate that our results are robust to a longer sample period which clearly demarcates the period into three sub-periods, namely before the practice of ICS early release, during the practice of ICS early release and the period when such practice is suspended, we perform further analysis using the S&P 500 exchange traded funds (ETFs) obtained from the Trade and Quote (TAQ) database for the period January 2004 – December 2014. To further demonstrate that early peek of ICS has appreciable effects on market quality, we utilize another macroeconomic announcement – news home sales – without the practice of early peek and study its effect on market quality.

- Table 7 about here -

[14] We thank the referee for suggesting a comparison be made of the opening position of HFTs in the two seconds before 9:55:00 and their trading volume at and after 9:55:00 to determine whether the profits can be realized. The results are available from the authors upon request.

Table 7 presents the returns and trade characteristics for ICS announcement two seconds prior and post-announcement for the period January 2004 – December 2014. This period is further divided into three distinct sub-periods: 2004/01-2006/12 (sub-period 1) is associated with the period before the practice of ICS early release; 2008/01-2013/06 (sub-period 2) is associated with the period when there was ICS early release; and 2013/07-2014/12 (sub-period 3) is associated with the period when the practice of ICS early release was suspended. Note that the period 2007 is excluded from our sub-period 1 sample because: (1) we are uncertain about the precise starting date of ICS early release in 2007, and (2) we must ensure that sub-period 1 signifies the period before the practice of ICS early release. The exclusion of 2007 data is also reflected in Hu, Pan, and Wang's (2017) study for similar reasons.

In summary, based on the results in Panels A to C, we find that: (1) there are statistically significant differences in stock returns, volatility, trading volume, and trading frequency in sub-period 2 compared to the lack of statistically significant difference in the corresponding variable in sub-period 1;[15] (2) in sub-period 2, the order of magnitude of these variables is substantially higher in the two seconds prior to the ICS release compared to the two seconds post-ICS release thereby suggesting that early release of ICS did exert some influence on price discovery and trading dynamic; and (3) the trade characteristics observed in sub-period 2 did not persist in sub-period 3 even though there are statistically significant differences in stock returns, volatility, trading volume and trading frequency. The order of magnitude is higher in the two seconds post-ICS release compared to the two seconds pre-ICS release, which concurs with the anticipated results when the practice of ICS early release was suspended.

Turning to Panel E, we observe contrasting results; for negative new home sales news, the fall in mean return is larger in 10:00:00-10:00:02 than that in 9:59:58-10:00:00 (i.e. -0.0284 vs. -0.0005). In the case of the negative ICS news, the mean return of S&P500 ETFs in the period January 2008 to June 2013, 9:54:58-9:55:00 falls by more than that in 9:55:00-9:55:02 (i.e. -0.0183 vs. -0.0016). This very different result is indicative of the impact of ICS early peek on market quality like stock return. The finding is the

[15] Note that in sub-period 1 (Panel A of Table 7), UOM publishes the ICS data at 10 a.m.; hence the two-second window is examined before and after 10:00:00 a.m.

exact opposite in the case of positive ICS news; mean returns are found to be higher for the period 9:54:58-9:55:00 compared to 9:55:00-9:55:02, while they are reversed for positive new home sales news. A similar pattern of results are observed for the other measures of market quality like volatility, volume and trade frequency.

- Table 8 about here -

We also perform difference-in-difference analysis for ETFs data and the results are presented in the table below. The difference-in-difference analysis involves two stages. In the first stage, we compute the difference in the variable of interest for the period (9:54:58-9:55:00) and (9:55:00-9:55:02). In the second stage, we test the difference in the variable of interest between the two consecutive periods with different practices of ICS early release, namely sub-period 1 (2004/01-2006/12) and sub-period 2 (2008/01-2013/06) as reported in Panel A, and sub-period 2 and sub-period 3 (2013/07-2014/12) as reported in Panel B. Referring to Table 8, for the variable return (%) in Panel A for negative consumer sentiment news in sub-period 1, the difference in return between the two periods (i.e. two seconds before and after the announcement) is small relative to sub-period 2. The t-statistics under the null that the difference in return across the two sub-periods is equal to zero is rejected at the 1% significance level. This is also true for the result of sub-periods 2 and 3. By and large, it can be seen that the test rejects the null of equality in return, volatility, volume and trade frequency across the two consecutive periods, thereby implying that the early release of ICS news in sub-period 2 did impact on the dynamic of return, volatility, volume and trade frequency.

6. Conclusion

High frequency traders have recently been in the limelight with controversial debates over their roles on price quality in the market. On 15 May 2013, the German High Frequency Trading Act ("Hochfrequenzhandelsgesetz") that addresses procedures to regulate algorithmic trading and high frequency trading (HFT), entered into force. It indicates the importance of information release and regulation of HFT. When Thomson Reuters/UM provided the two-second advance peek into ICS to its

elite group of subscribers, it provided an opportunity for high frequency traders to utilize this early information release. HFTs' speed advantage through the use of rapid computer algorithms coupled with information advantage through the advance peek has been scrutinized by the U.S. Securities and Exchange Commission. It is in this context that we study the trading behavior of informed high frequency traders and their market microstructure implications so as to inform market regulators on the appropriate policy action for the practice of advance peek.

Our key contribution is that we identify HFTs, who as a group strongly benefit from the early-access service. Our empirical results demonstrate that liquidity-demanding HFTs stand to benefit the most from the early release of ICS. We show that trading volume increases sharply during the advance peek. As informed HFTs tend to be better informed about the direction of stock price movements, they exhibit larger trade imbalance with the volume of buyer (seller)-initiated transactions exceeding the volume of seller (buyer)-initiated transactions for positive (negative) ICS news. Stock returns are found to react with a two-second lag to informed HFTs' trade imbalance. Finally, we provide an estimate of the profit made by informed HFTs, which is substantially larger than that of non-informed traders, confirming concerns raised by the SEC. Our empirical evidence sheds some light on possible concerns, which have emerged in the public domain, over the harmful effects of tiered information disclosure in financial markets.

While the advance peek gives HFTs an informational advantage that may be deemed a violation of a level playing field for equal information, the two-second advance peek remains a highly controversial topic. From the perspective of procedural fairness, or equal application of the rules, the advance peek does not appear to contravene this criterion. To the extent that any trader is able to generate a competitive advantage through investment in computer algorithms for a speed advantage, the two-second advance peek is a service that is made available to financial practitioners who subscribe to Thomson Reuters' financial data services and is not exclusively offered to HFTs. However, underlying the argument that anyone can purchase and utilize these services is the assumption that all parties will benefit from them equally. Clearly, this is not the case. The two seconds early release is much more likely to benefit high-frequency traders with the ability to execute a massive number of trades per day, more than average

institutional investors using long-term trading strategies. Further, permitting two-second tiered information disclosure in the market can lead to informational asymmetries, which allow certain high-frequency traders to engage in predatory trading practices that take advantage of other investors without premier access to information.

Given that the advance peek is designed for traders who are equipped with high-speed technology, this practice grants HFTs an added advantage ahead of ordinary traders. On that basis, the advance peek may be regarded as a practice favoring those with faster and closer access to financial markets, which may lead to public speculation about the integrity of financial markets. Permitting a two-tiered system in which HFTs are able to prey upon ordinary traders is likely to cause investors to lose confidence and make them less willing to take action in the market. In the worst case scenario, this may even lead to certain participants exiting from the marketplace. The result of fast traders obtaining information before slow traders can also generate adverse selection which is not internalized. These negative externalities can result in overinvestment in equilibrium (Biais, Foucault, and Moinas, 2015). While the capital markets rely on investors obtaining data for prices to better reflect the fundamental values of assets, the resources expended to provide and process faster access to data are in effect not creating new data but instead simply accessing it more quickly (Angel and McCabe, 2018). If permitted, such practice may encourage data providers to sell tiered information to traders at a premium cost leading to misallocation of resources. There are also valid concerns that the appropriation of some part of the returns to investments made at the expense of other shareholders can give rise to economically inefficient levels of corporate investment (Manove, 1989).[16] Given the myriad concerns over the practice of insider trading 2.0, it is no surprise that the SEC has stepped in to curtail this predatory endeavor.

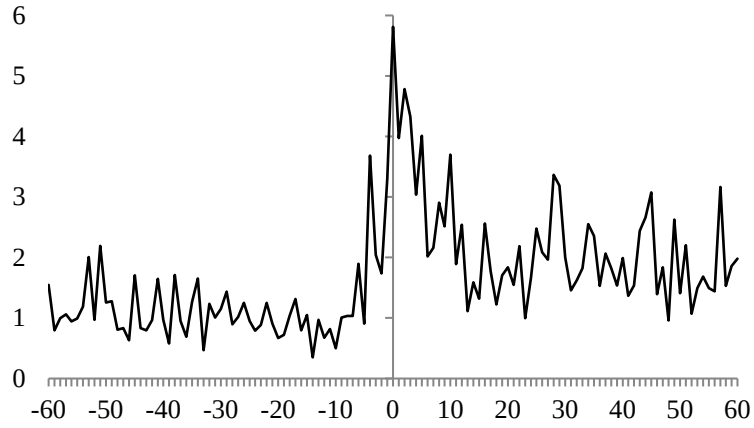
[16] While Manove (1989) develops a model that represents insider trading in the shares of a single corporation, that corporation could represent an entire securities market (p. 843). The idea is that in the presence of pervasive insider trading, future outside buyers of shares (who know they are subject to adverse selection) are unwilling to pay the full expected value of forthcoming investment proceeds. In so doing incumbent shareholders are unable to recover the full expected value of the returns to corporate investments. Accordingly, there is a lack of shareholder support for corporate investment.

Appendix

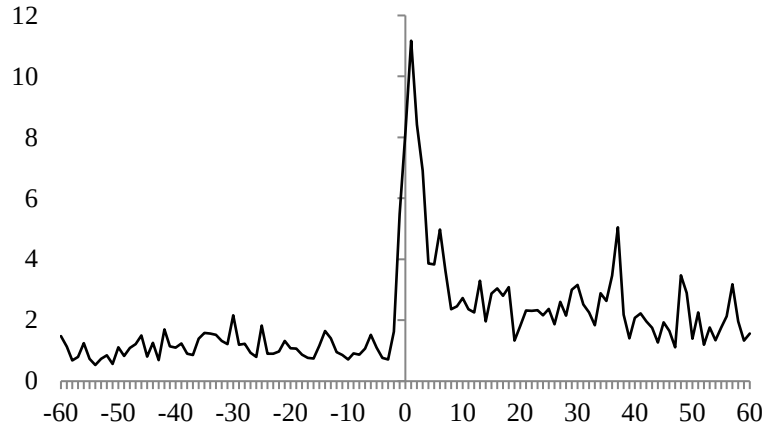
Figure A1. Intraday Patterns on New Home Sales Announcement

The figures below show intraday trading patterns for HFT spanning two minutes (one minute before and one minute after the New Home Sales announcement) on days with New Home Sales announcements. The announcements are further classified as positive or negative news. The sample covers the period January 1, 2008 to August 31, 2009, which comprises 20 announcements days. Figures on the left-hand (right-hand) column are for positive (negative) New Home Sales announcements. Positive (negative) announcements are for announced New Home Sales that are higher (lower) than analysts' forecast average. The x-axis denotes time in seconds such that t = 0 is associated with the New Home Sales announcement at 10:00 a.m. The vertical dot-lines are for t = 0, indicating the exact time for the New Home Sales announcement. Trading volume (Figures (a) and (b)) is measured by the number of shares scaled by daily average one-second volume, trade imbalance (Figures (c) and (d)) is defined as the number of shares in buyer-initiated transactions minus seller-initiated transactions, and returns (Figures (e) and (f)) are defined as the first difference of the log of stock price calculated from NBBO quotes.

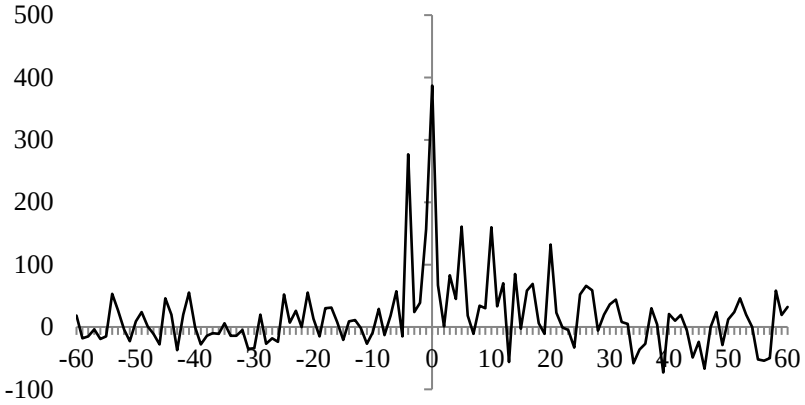
(a) Trading Volume for Positive News



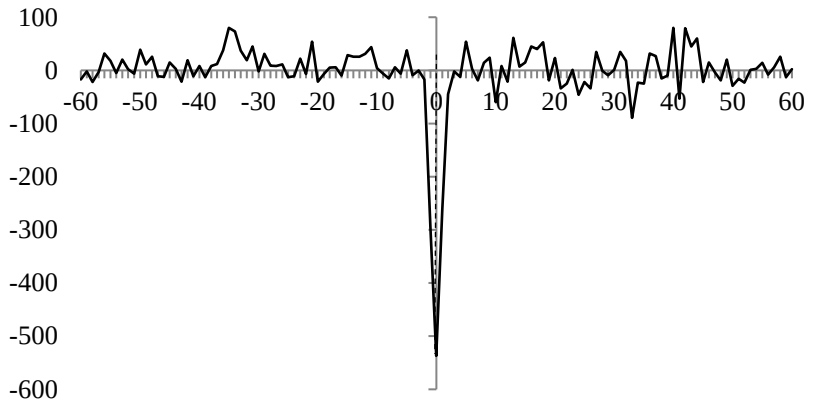
(b) Trading Volume for Negative News



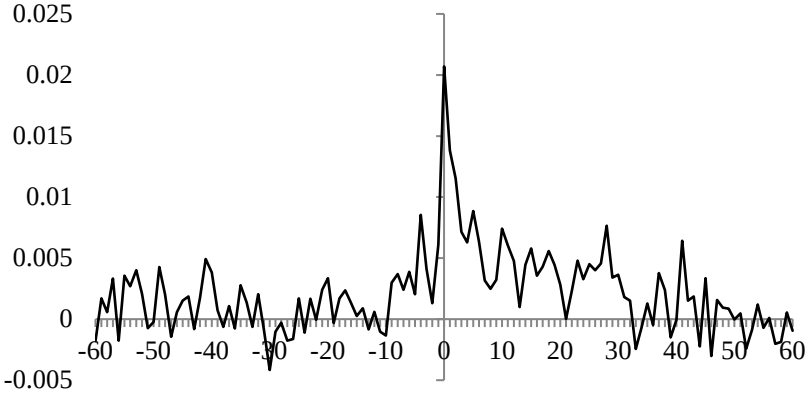
(c) Trade Imbalance for Positive News



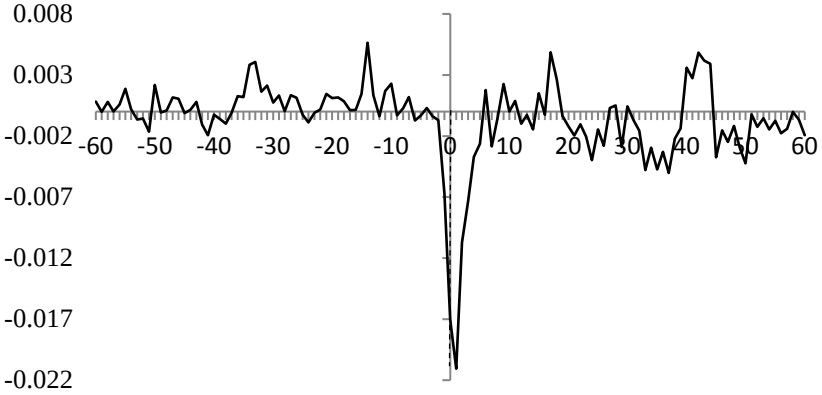
(d) Trade Imbalance for Negative News



(e) Returns (NBBO) for Positive News



(f) Returns (NBBO) for Negative News



References

Adams, G., G. McQueen, and R. Wood, 2004. The effects of inflation news on high frequency stock returns, *Journal of Business* 77, 547-574.

Ait-Sahalia Y, and M. Saglam, 2017. High frequency market making: Optimal quoting, Working Paper, Department of Economics, Princeton University.

Aitken, M.J., A. Aspris, S. Foley, and F.H.D.B. Harris, 2018. Market fairness: The poor country cousin of market efficiency, *Journal of Business Ethics* 147, 5-23.

Aitken, M.J., D. Cumming, and F. Zhan, 2015. High frequency trading and end-of-day price dislocation, *Journal of Banking & Finance* 59, 330-349.

Andersen, T., T. Bollerslev, F. Diebold, and C. Vega, 2003. Micro effects of macro announcements: Real-time price discovery in foreign exchange, *American Economic Review* 93, 38-62.

Angel, J., 2014. When finance meets physics: The impact of the speed of light on financial markets and their regulation, *Financial Review* 49 271-281.

Angel, J., and D. McCabe, 2018. Insider trading 2.0? The ethics of information sales, *Journal of Business Ethics* 147, 747-760.

Balduzzi, P., E. J. Elton, and T. C. Green, 2001. Economic news and bond prices: Evidence from the U.S. treasury market, *Journal of Financial and Quantitative Analysis* 36, 523-563.

Balp, G., and G. Strampelli, 2018. Preserving capital markets efficiency in the high-frequency trading era, Bocconi Legal Studies Research Paper No. 3097723.

Baron, M., J. Brogaard, B. Hagströmer, and A. Kirilenko, 2018. Risk and return in high-frequency trading, *Journal of Financial and Quantitative Analysis*, forthcoming.

Bernales, A., 2014. Algorithmic and high frequency trading in dynamic limit order markets, Working Paper, University of Chile.

Bernile, G., J. Hu, and Y. Tang, 2016. Can information be locked-up? Informed trading ahead of macro news announcements, *Journal of Financial Economics* 121, 496-520.

Biais, B., T. Foucault, and S. Moinas, 2015. Equilibrium fast trading, *Journal of Financial Economics* 116, 292-313.

Bongaerts D, and M. Van Achter, 2016. High-frequency trading and market stability, Working Paper, Rotterdam School of Management.

Boyd, J., J. Hu, and R. Jagannathan, 2005. The stock markets' reaction to unemployment news: Why bad news is usually good for stocks, *Journal of Finance* 60, 649-672.

Brogaard, J., 2010. High frequency trading and its impact on market quality, Working paper, Northwestern University.

Brogaard, J., T. Hendershott, and R. Riordan, 2014. High frequency trading and price discovery, *Review of Financial Studies* 27, 2267-2306.

Brunnermeier, M., 2005. Information leakage and market efficiency, *Review of Financial Studies* 18, 417-457.

Chakravarty, S., and J. J. McConnell, 1997. An analysis of prices, bid/ask spreads, and bid and ask depths surrounding Ivan Boesky's illegal trading in Carnation's stock, *Financial Management* 26, 18-34.

Chakravarty, S., and J. J. McConnell, 1999. Does insider trading really move stock prices? *Journal of Financial and Quantitative Analysis* 34, 191-209.

Cornell, B., and E. R. Sirri, 1992. The reaction of investors and stock prices to insider trading, *Journal of Finance* 47, 1031-1059.

Ederington, L., and J. Lee, 1993. How markets process information: News releases and volatility, *Journal of Finance* 48, 1161-1191.

Erenburg, G., A. Kurov, and D. J. Lasser, 2006. Trading around macroeconomic announcements: Are all traders created equal? *Journal of Financial Intermediation* 15, 470-493.

Fishe, R. P., and M. A. Robe, 2004. The impact of illegal insider trading in dealer and specialist markets: Evidence from a natural experiment, *Journal of Financial Economics* 71, 461-488.

Flannery, M., and A. Protopapadakis, 2001. Macroeconomic factors do influence aggregate stock returns, *Review of Financial Studies* 15, 751-782.

Fleming, M., and E. Remolona, 1999. Price formation and liquidity in the U.S. treasury market: The response to public information, *Journal of Finance* 54, 1901-1915.

Foucault, T., J. Hombert, and I. Rosu, 2016. News trading and speed, *Journal of Finance* 71, 335-382.

Goettler, R., C. Parlour, and U. Rajan, 2009. Informed traders in limit order markets, *Journal of Financial Economics* 93, 67–87.

Goldstein, M.A., P. Kumar, and F. C. Graves, 2014. Computerized and high-frequency trading, *Financial Review* 49, 177-202.

Hendershott, T., C. M. Jones, and A. J. Menkveld, 2011. Does algorithmic trading improve liquidity? *Journal of Finance* 66, 1-33.

Hendershott, T., and R. Riordan, 2013. Algorithmic trading and the market for liquidity, *Journal of Financial and Quantitative Analysis* 48, 1001-1024.

Hirschey, M., and J. K. Zaima, 1989. Insider trading, ownership structure, and the market assessment of corporate sell-offs, *Journal of Finance* 44, 971-980.

Hirschey, N. H., 2018. Do high-frequency traders anticipate buying and selling pressure? Unpublished working paper. http://ssrn.com/abstract=2238516.

Hirshleifer, D., A. Subrahmanyam, and S. Titman, 1994. Security analysis and trading patterns when some investors receive information before others, *Journal of Finance* 49, 1665-1698.

Hu, G.X., J. Pan, and J. Wang, 2017. Early Peek Advantage? Efficient price discovery with tiered information disclosure, *Journal of Financial Economics* 126, 399-421.

Inci, A. C., B. Lu, and H. N. Seyhun, 2010. Intraday behavior of stock prices and trades around insider trading, *Financial Management* 39, 323-363.

Irvine, P., M. Lipson, and A. Puckett, 2007. Tipping, *Review of Financial Studies* 20, 741-768.

Jarnecic, E., and M. Snape, 2014. The provision of liquidity by high-frequency participants, *Financial Review* 49, 371-394.

Javers, E., 2013. Thomson Reuters gives elite traders early advantage, *CNBC*, June 12 2013. http://www.cnbc.com/id/100809395.

John, K., and L. H. P. Lang, 1991. Insider trading around dividend announcements: Theory and evidence, *Journal of Finance* 46, 1361-1389.

Jovanovic B., and A. J. Menkveld, 2016. Middlemen in limit-order markets, Working Paper, Vrije Universiteit Amsterdam.

Kadan, O., R. Michaely, and P. Moulton, 2015. Speculating on private information: Buy the rumor, sell the news, Unpublished working paper. http://ssrn.com/abstract=2427282.

Kirilenko, A. A., A. Kyle, M. Samadi, and T. Tuzun, 2017. The Flash Crash: the impact of high frequency trading on an electronic market, *Journal of Finance* 72, 967–998.

Kurov, A., A. Sancetta, G. Strasser, and M. H. Wolfe, 2017. Price drift before U.S. macroeconomic news: Private information about public announcements? *Journal of Financial and Quantitative Analysis*, forthcoming.

Kyle, A. S., 1985. Continuous auctions and insider trading, *Econometrica* 53, 1315-1335.

Lattman, P., 2013. Thomson Reuters to suspend early peeks at key index, *New York Times*, July 7, 2013. http://dealbook.nytimes.com/2013/07/07/thomson-reuters-to-suspend-early-peeks-at-key-index/?_r=0.

Laughlin, G., A. Aguirre, and J. Grundfest, 2014. Information transmission between financial markets in Chicago and New York, *Financial Review* 49, 283-312.

Lee, D. S., W. H. Mikkelson, and M. M. Partch, 1992. Managers' trading around stock repurchases, *Journal of Finance* 47, 1947-1962.

Lucca, D., and E. Moench, 2015. The pre-FOMC announcement drift, *Journal of Finance* 70, 329-371.

Manahov, V., 2016. Front-running scalping strategies and market manipulation: Why does high-frequency trading need stricter regulation? *Financial Review* 51, 363-402.

Manove, M., 1989. The harm from insider trading and informed speculation, *Quarterly Journal of Economics* 104, 823-845.

Menkveld, A.J., 2016. The economics of high frequency trading: Taking stock, *Annual Review of Financial Economics* 8, 1-24.

Meulbroek, L. K., 1992. An empirical analysis of illegal insider trading, *Journal of Finance* 47, 1661-1699.

O'Hara, M., 2015. High frequency market microstructure, *Journal of Financial Economics* 116, 257-270.

Rogers, J., D. Skinner, and S. Zechman, 2017. Run EDGAR run: SEC dissemination in a high-frequency world, *Journal of Accounting Research* 55, 459-505.

Scholtus, M., D. van Dijk, and B. Frijns, 2014. Speed, algorithmic trading, and market quality around macroeconomic news announcements, *Journal of Banking & Finance* 38, 89-105.

Seyhun, H. N., 1986. Insiders' profits, costs of trading, and market efficiency, *Journal of Financial Economics* 16, 189-212.

Seyhun, H. N., 1990. Do bidder managers knowingly pay too much for target firms? *Journal of Business* 63, 439-464.

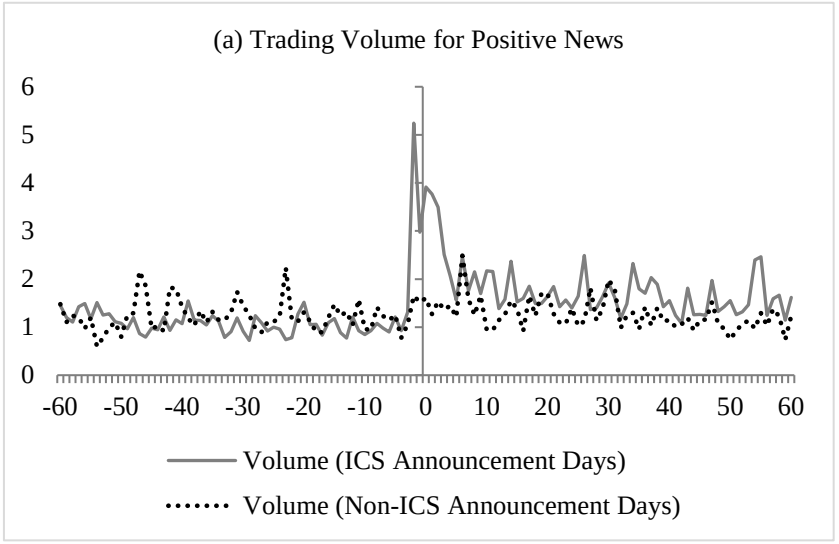
Seyhun, H. N., 1992. Why does aggregate insider trading predict future stock returns? *Quarterly Journal of Economics* 107, 1303-1331.

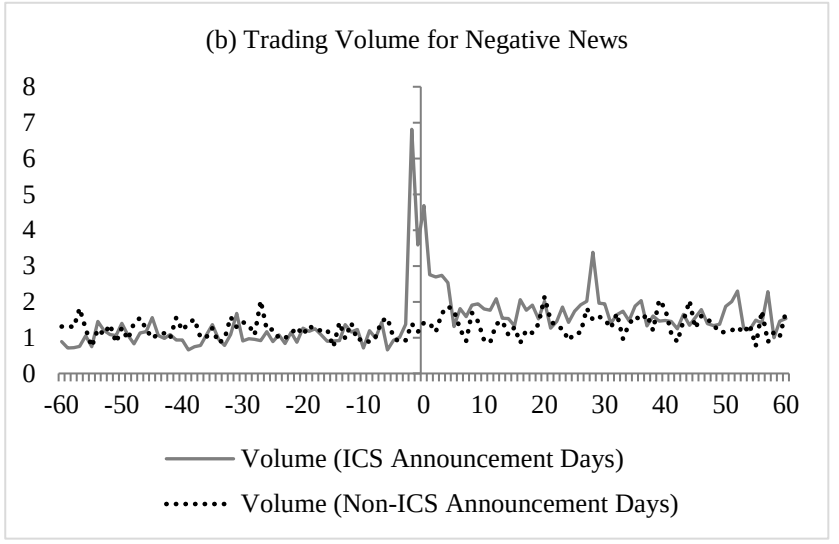
Tetlock, P., 2010. Does public financial news resolve asymmetric information? *Review of Financial Studies* 23, 3520-3557.

White H., 1980. A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroscedasticity, *Econometrica* 48, 4, 817-38.

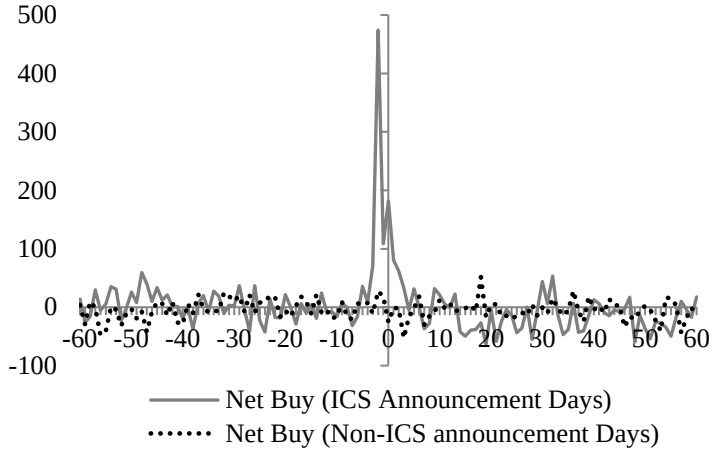
Figure 1. Intraday Patterns on ICS Announcement and Non-announcement Days.

The figures below show intraday trading patterns for HFT spanning two minutes (one minute before and one minute after the ICS announcement) on days with or without ICS announcements. ICS announcement days are ICS announcement Fridays and non-ICS announcement days are also Fridays but with no ICS announcements made when there is no ICS announcement. ICS announcements are further classified as positive or negative news. The solid (dashed) lines are for days with (without) announcements. The sample covers the period January 1, 2008 to August 31, 2009, which comprises 40 announcements days. Figures on the left-hand (right-hand) column are for positive (negative) ICS announcements. Positive (negative) ICS announcements are for announced ICS that are higher (lower) than analysts' forecast average. The x-axis denotes time in seconds such that t = 0 is associated with the ICS announcement at 9:55 a.m. The vertical dot-lines are for t = -2, indicating the exact time for the two-second advance peek into ICS. Trading volume (Figures (a) and (b)) is measured by the number of shares scaled by daily average one-second volume, trade imbalance (Figures (c) and (d)) is defined as the number of shares in buyer-initiated transactions minus seller-initiated transactions, and returns (Figures (e) and (f)) are defined as the first difference of the log of stock price calculated from NBBO quotes.

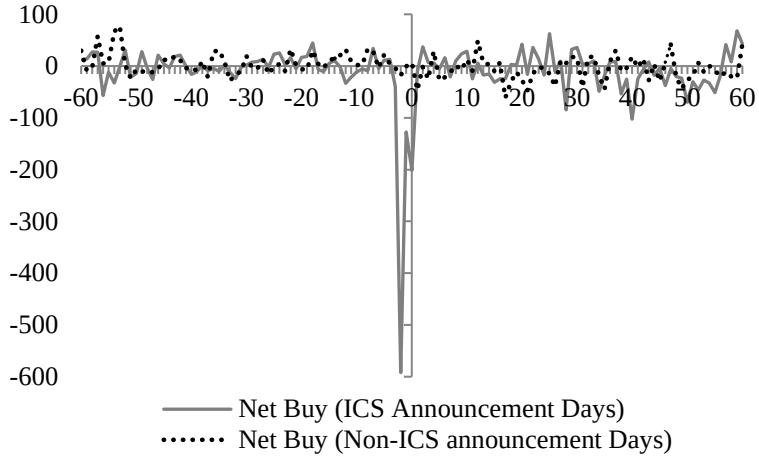




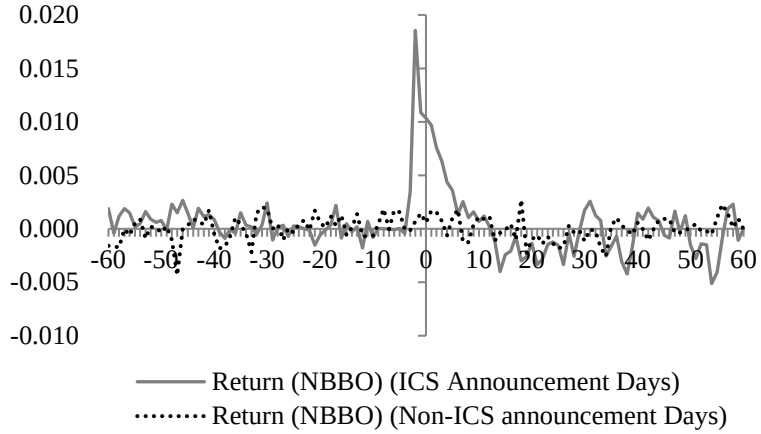
(c) Trade Imbalance for Positive News



(d) Trade Imbalance for Negative News



(e) Returns for Positive News



(f) Returns for Negative News

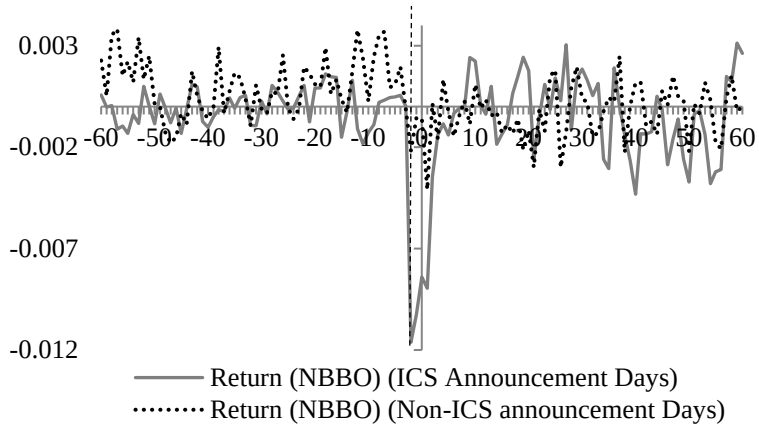


Table 1. Return and Trade Characteristics for ICS Announcement and Non-ICS Announcement Days for NASDAQ Data

This table presents mean difference tests of return, volume and trade imbalance on ICS announcement and non-ICS announcement days. The advance peek on ICS occurred at 09:54:58 EST during the sample period from January 1, 2008 to August 31, 2009. When the value for the ICS is higher (lower) than the median forecast from the Thomson Reuters Survey of Economists, it is regarded as positive (negative) consumer sentiment news. We compute the average one-second interval stock return, trade volume, and trade imbalance from 9:54:58 to 9:55:00 and from 9:55:00 to 9:55:02. HFT^D (non-HFT^D) denote liquidity demanders of (non-) high frequency traders which is made up of the 26 accounts. Returns are defined as the first difference of the log of stock price calculated from NBBO quotes, trading volume is measured by the number of shares traded, and trade imbalance is defined as the difference between buyer-initiated transactions and seller-initiated transactions. ICS announcement days are ICS announcement Fridays and non-ICS announcement days are also Fridays but with no ICS announcements made when there is no ICS announcement. The superscripts *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Negative Consumer Sentiment News			**Positive Consumer Sentiment News**		
	9:54:58 - 9:55:00	9:55:00 - 9:55:02	t stat.	9:54:58 - 9:55:00	9:55:00 - 9:55:02	t stat.
Panel A: ICS announcement days						
Return (%)	-0.0109	-0.0087	(-2.50) **	0.0147	0.0100	(5.04) ***
Volume (scaled by average one-second volume each day)						
HFT^D	3.04	1.66	(3.68) ***	2.23	1.97	(1.08)
Non-HFT^D	2.16	2.07	(0.38)	1.88	1.87	(0.02)
Trade imbalance						
HFT^D	-186.63	-56.85	(-5.57) ***	168.97	101.76	(2.91) ***
Non-HFT^D	-172.95	-49.39	(-4.38) ***	122.49	29.56	(4.96) ***
Panel B: Non-ICS announcement days						
Return (%)	-0.0014	-0.0023	(0.81)	0.0011	0.0011	(-0.09)
Volume (scaled by average one-second volume each day)						
HFT^D	0.47	0.45	(0.23)	0.54	0.56	(-0.19)
Non-HFT^D	0.81	0.96	(-0.86)	1.05	0.88	(0.68)
Trade imbalance						
HFT^D	-7.76	-11.24	(0.49)	17.88	8.34	(0.86)
Non-HFT^D	-1.42	-8.76	(0.80)	4.70	-21.53	(0.99)

Table 2. Determinants of Trade Imbalance of Liquidity-Demanding HFTs and Non-HFTs

This table presents the pooled OLS regression results for the determinants of trade imbalance of liquidity-demanding HFT^D and non-HFT^D. We report the coefficients from a regression of trade imbalance in 300-second intervals before and after the announcements from January 1, 2008 to August 31, 2009. TI denotes one-second interval trade imbalance, which is measured by the number of shares in buy-initiated transactions minus sell-initiated transactions. All dependent variables are standardized relative to the average of each stock on each announcement day. *EarlyPeek* and *Release* are time interval dummy variables that equal one for the intervals [9:54:58, 9:54:59] and [9:55:00, 9:55:01], and zero otherwise. *Final* is a dummy that equals one for Thomson Reuters/UM index of consumer sentiment final reports and zero for mid-term reports. *Large* is a dummy variable for stocks with large market capitalization, such that it takes the value of 1 if they fit the definition and 0 otherwise. *Surprise* is the absolute difference between actual ICS and expected ICS. Standard errors are corrected for heteroskedasticity using the White (1980) method. The t-statistics are shown in parentheses next to the coefficients. Here, *, **, and *** denote significance at the 1%, 0.5%, and 0.1% levels, respectively. Significance levels (or critical t-values) are adjusted to mitigate overstatement of statistical significance arising from large samples (i.e. Lindley's paradox).

	Negative Consumer Sentiment News				Positive Consumer Sentiment News			
	$TI\_HFT^D_t$		$TI\_non\text{-}HFT^D_t$		$TI\_HFT^D_t$		$TI\_non\text{-}HFT^D_t$	
Panel A: Baseline								
Intercept	0.0051	(2.10)	0.0018	(0.73)	-0.0063	(-3.30)	-0.0008	(-0.39)
EarlyPeek	-0.6063	(-14.71) ***	-0.3212	(-10.33) ***	0.5021	(15.87) ***	0.2157	(9.31) ***
Release	-0.3022	(-9.07) ***	-0.1836	(-7.53) ***	0.4205	(13.30) ***	0.1540	(6.87) ***
Final	0.0002	(0.09)	0.0038	(1.55)	0.0041	(2.32)	0.0036	(2.02)
Large	-0.0035	(-1.86)	-0.0022	(-1.16)	0.0019	(1.15)	0.0045	(2.67) *
Surprise	-0.0001	(-0.30)	0.0007	(1.46)	0.0014	(3.21) **	-0.0007	(-1.57)
Obs.	1,276,524		1,276,524		1,560,196		1,560,196	
Adj. R-sq. (%)	0.16		0.04		0.14		0.02	
Panel B: Interact with large firm dummy								
Intercept	0.0041	(1.71)	0.0009	(0.35)	-0.0053	(-2.77) *	-0.0002	(-0.12)
EarlyPeek	-0.3659	(-8.40) ***	-0.1104	(-5.21) ***	0.3008	(8.26) ***	0.0580	(2.84) **
Release	-0.2592	(-5.82) ***	-0.1112	(-4.28) ***	0.3160	(9.04) ***	0.1526	(5.39) ***
Final	0.0002	(0.09)	0.0038	(1.55)	0.0041	(2.32)	0.0036	(2.02)
Large	-0.0007	(-0.38)	0.0006	(0.32)	-0.0011	(-0.63)	0.0029	(1.75)
Surprise	-0.0001	(-0.30)	0.0007	(1.46)	0.0014	(3.21) **	-0.0007	(-1.57)
EarlyPeek×Large	-0.7092	(-7.38) ***	-0.6218	(-7.45) ***	0.5940	(8.52) ***	0.4652	(7.96) ***
Release×Large	-0.1270	(-1.98)	-0.2138	(-3.74) ***	0.3083	(4.26) ***	0.0040	(0.09)
Obs.	1,276,524		1,276,524		1,560,196		1,560,196	
Adj. R-sq. (%)	0.20		0.08		0.18		0.04	
Panel C: Interact with final report dummy								
Intercept	0.0074	(3.03) **	0.0030	(1.23)	-0.0074	(-3.86) ***	-0.0010	(-0.50)
EarlyPeek	-1.0414	(-14.73) ***	-0.5561	(-10.22) ***	0.7183	(13.77) ***	0.2933	(7.68) ***
Release	-0.5494	(-9.48) ***	-0.3201	(-7.78) ***	0.5306	(9.55) ***	0.1371	(4.70) ***
Final	-0.0049	(-2.05)	0.0010	(0.42)	0.0061	(3.45) ***	0.0040	(2.23)
Large	-0.0035	(-1.86)	-0.0022	(-1.16)	0.0019	(1.15)	0.0045	(2.67) *
Surprise	-0.0001	(-0.30)	0.0007	(1.46)	0.0014	(3.21) **	-0.0007	(-1.57)
EarlyPeek×Final	0.9791	(13.19) ***	0.5286	(9.42) ***	-0.3962	(-6.14) ***	-0.1422	(-3.00) **
Release×Final	0.5562	(9.22) ***	0.3071	(6.81) ***	-0.2018	(-3.08) **	0.0310	(0.70)
Obs.	1,276,524		1,276,524		1,560,196		1,560,196	
Adj. R-sq. (%)	0.26		0.07		0.16		0.03	
Panel D: Interact with surprise								
Intercept	0.0020	(0.83)	0.0003	(0.11)	-0.0045	(-2.38)	-0.0005	(-0.26)
EarlyPeek	-0.0748	(-3.03) **	0.0165	(0.97)	0.3404	(8.28) ***	0.1767	(6.22) ***
Release	-0.0619	(-2.12)	-0.0608	(-2.39)	0.0397	(0.73)	0.1121	(3.40) ***

Final	0.0002	(0.09)		0.0038	(1.56)		0.0041	(2.32)		0.0036	(2.02)	
Large	-0.0035	(-1.86)		-0.0022	(-1.16)		0.0019	(1.15)		0.0045	(2.67)	*
Surprise	0.0010	(2.13)		0.0013	(2.66)	*	0.0006	(1.45)		-0.0008	(-1.85)	
EarlyPeek×Surprise	-0.2507	(-14.55)	***	-0.1243	(-9.55)	***	0.0716	(5.35)	***	0.0173	(2.16)	
Release×Surprise	-0.0885	(-6.81)	***	-0.0452	(-5.12)	***	0.1685	(6.09)	***	0.0186	(1.81)	
Obs.	1,276,524			1,276,524			1,560,196			1,560,196		
Adj. R-sq. (%)	0.31			0.08			0.19			0.03		
Panel E: All interaction terms												
Intercept	0.0028	(1.17)		0.0005	(0.22)		-0.0040	(-2.13)		-0.0001	(-0.06)	
EarlyPeek	0.1565	(2.85)	**	0.0854	(2.05)		0.3935	(5.40)	***	0.1248	(2.52)	
Release	-0.3830	(-4.23)	***	-0.2078	(-3.02)	**	-0.1612	(-1.72)		0.0494	(0.88)	
Final	-0.0020	(-0.83)		0.0023	(0.94)		0.0048	(2.73)	*	0.0038	(2.13)	
Large	-0.0007	(-0.38)		0.0006	(0.32)		-0.0011	(-0.63)		0.0029	(1.75)	
Surprise	0.0007	(1.52)		0.0011	(2.24)		0.0007	(1.62)		-0.0008	(-1.81)	
EarlyPeek×Final	0.1986	(3.79)	***	0.1775	(4.32)	***	-0.3278	(-4.71)	***	-0.1363	(-2.65)	*
Release×Final	0.4556	(5.89)	***	0.2747	(4.34)	***	0.1242	(1.83)		0.0789	(1.47)	
EarlyPeek×Large	-0.7092	(-7.71)	***	-0.6218	(-7.57)	***	0.5940	(8.57)	***	0.4652	(7.97)	***
Release×Large	-0.1270	(-2.01)		-0.2138	(-3.77)	***	0.3083	(4.34)	***	0.0040	(0.09)	
EarlyPeek×Surprise	-0.2248	(-13.85)	***	-0.1011	(-8.11)	***	0.0381	(2.68)	*	0.0033	(0.39)	
Release×Surprise	-0.0290	(-1.72)		-0.0093	(-0.75)		0.1812	(6.04)	***	0.0266	(2.13)	
Obs.	1,276,524			1,276,524			1,560,196			1,560,196		
Adj. R-sq. (%)	0.36			0.12			0.23			0.04		

Table 3. The Effects of HFT^D and Non-HFT^D Trade Imbalance on Stock Returns

This table presents the pooled OLS regression results for the effects of HFT^D and Non-HFT^D trade imbalance (*TI*) on one-second stock returns. We analyze transaction data in 300-second intervals before and after the announcements from January 1, 2008 to August 31, 2009. Trade imbalance denotes the number of shares in buyer-initiated transactions minus seller-initiated transactions. Trade imbalance for each stock is standardized by the type of investors on each day. The dummy variable *Release* takes the value of 1 for [9:55:00, 9:55:01) and zero otherwise. Standard errors are corrected for heteroscedasticity using the White (1980) method. The t-statistics are shown in parentheses next to the coefficients. *, **, and *** denote significance at the 1%, 0.5%, and 0.1% levels, respectively. Significance levels (or critical t-values) are adjusted to mitigate overstatement of statistical significance arising from large samples (i.e. Lindley's paradox).

	Negative Consumer Sentiment News				Positive Consumer Sentiment News			
	Model 1		Model 2		Model 1		Model 2	
Intercept	0.0002	(8.05)***	0.0002	(8.04)***	0.0002	(6.22)***	0.0002	(6.20)***
$TI\_HFT^D_t$	0.5265	(32.08)***	0.5302	(31.80)***	0.5716	(43.28)***	0.5746	(42.88)***
$TI\_HFT^D_{t-1}$	0.1038	(15.42)***	0.1023	(15.02)***	0.1036	(15.44)***	0.1019	(14.99)***
$TI\_HFT^D_{t-2}$	0.0291	(5.87)***	0.0274	(5.43)***	0.0316	(4.35)***	0.0302	(4.08)***
$TI\_HFT^D_{t-3}$	0.0155	(3.62)***	0.0145	(3.34)***	0.0083	(2.11)	0.0073	(1.85)
$TI\_HFT^D_{t-4}$	0.0072	(2.18)	0.0073	(2.21)	0.0087	(2.46)	0.0088	(2.47)
$TI\_HFT^D_{t-5}$	0.0094	(2.47)	0.0094	(2.45)	0.0035	(0.91)	0.0036	(0.94)
$Release \times TI\_HFT^D_t$			-0.2177	(-4.32)***			-0.1638	(-2.69)*
$Release \times TI\_HFT^D_{t-1}$			0.0773	(1.91)			0.1072	(2.65)*
$Release \times TI\_HFT^D_{t-2}$			0.0723	(2.82)**			0.0716	(2.85)**
$Release \times TI\_HFT^D_{t-3}$			0.0518	(2.03)			0.0720	(2.77)*
$Release \times TI\_HFT^D_{t-4}$			-0.0190	(-0.44)			-0.0213	(-0.33)
$Release \times TI\_HFT^D_{t-5}$			0.0517	(1.02)			-0.0398	(-0.76)
$TI\_Non\text{-}HFT^D_t$	0.5546	(38.22)***	0.5561	(38.02)***	0.5727	(42.58)***	0.5747	(42.42)***
$TI\_Non\text{-}HFT^D_{t-1}$	0.1109	(14.04)***	0.1109	(13.93)***	0.0952	(13.42)***	0.0947	(13.30)***
$TI\_Non\text{-}HFT^D_{t-2}$	0.0248	(5.08)***	0.0247	(5.01)***	0.0142	(3.23)**	0.0140	(3.16)**
$TI\_Non\text{-}HFT^D_{t-3}$	0.0117	(2.89)**	0.0115	(2.81)**	0.0170	(3.45)***	0.0169	(3.40)***
$TI\_Non\text{-}HFT^D_{t-4}$	0.0012	(0.30)	0.0012	(0.28)	0.0086	(1.55)	0.0080	(1.45)
$TI\_Non\text{-}HFT^D_{t-5}$	-0.0029	(-0.67)	-0.0026	(-0.61)	0.0151	(3.61)***	0.0151	(3.61)***
$Release \times TI\_Non\text{-}HFT^D_t$			-0.1852	(-3.29)***			-0.2344	(-2.77)
$Release \times TI\_Non\text{-}HFT^D_{t-1}$			0.0055	(0.14)			0.0999	(1.37)
$Release \times TI\_Non\text{-}HFT^D_{t-2}$			-0.0108	(-0.26)			-0.0031	(-0.10)
$Release \times TI\_Non\text{-}HFT^D_{t-3}$			0.0108	(0.42)			-0.0066	(-0.17)
$Release \times TI\_Non\text{-}HFT^D_{t-4}$			0.0274	(0.50)			0.1523	(1.67)
$Release \times TI\_Non\text{-}HFT^D_{t-5}$			-0.1229	(-2.40)			-0.0024	(-0.05)
Obs.	1,276,524		1,276,524		1,560,196		1,560,196	
Adj. R-sq. (%)	6.42		6.43		6.07		6.08	

Table 4. The Effects of HFT^D and Non-HFT^D Trade Imbalance on Stock Returns for different market capitalization

This table presents the pooled OLS regression results for the effects of HFT^D and Non-HFT^D trade imbalance (*TI*) on one-second stock returns. We analyze transaction data in 300-second intervals before and after the announcements from January 1, 2008 to August 31, 2009. Trade imbalance denotes the number of shares in buyer-initiated transactions minus seller-initiated transactions. Trade imbalance for each stock is standardized by the type of investors on each day. The dummy variable *Release* takes the value of 1 for [9:55:00, 9:55:01) and zero otherwise. The stocks are categorized into large, medium and small market capitalization. Standard errors are corrected for heteroscedasticity using the White (1980) method. The t-statistics are shown in parentheses next to the coefficients. Here, *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Negative Consumer Sentiment News						Positive Consumer Sentiment News					
	Large size		Medium size		Small size		Large size		Medium size		Small size	
Intercept	0.0002	(5.48) ***	0.0002	(4.93) ***	0.0003	(4.13) ***	0.0001	(1.82) *	0.0002	(5.41) ***	0.0002	(3.54) ***
$TI\_HFT^D_t$	0.6083	(54.61) ***	0.4568	(25.36) ***	0.5308	(10.19) ***	0.6689	(62.34) ***	0.5211	(28.82) ***	0.5360	(14.58) ***
$TI\_HFT^D_{t-1}$	0.1118	(20.72) ***	0.1053	(9.75) ***	0.0869	(4.70) ***	0.1000	(19.51) ***	0.1241	(10.53) ***	0.0762	(4.57) ***
$TI\_HFT^D_{t-2}$	0.0040	(0.88)	0.0322	(4.80) ***	0.0508	(3.53) ***	0.0118	(2.35) **	0.0341	(4.82) ***	0.0461	(2.06) **
$TI\_HFT^D_{t-3}$	-0.0021	(-0.53)	0.0270	(3.47) ***	0.0229	(2.19) **	0.0040	(1.08)	0.0145	(2.62) ***	0.0052	(0.49)
$TI\_HFT^D_{t-4}$	-0.0018	(-0.46)	0.0092	(1.83) *	0.0188	(2.26) **	-0.0041	(-1.18)	0.0250	(4.20) ***	0.0055	(0.64)
$TI\_HFT^D_{t-5}$	0.0027	(0.66)	0.0147	(2.68) ***	0.0122	(1.17)	-0.0079	(-2.31) **	0.0191	(3.38) ***	0.0016	(0.15)
$Release \times TI\_HFT^D_t$	-0.2265	(-2.75) ***	-0.1888	(-2.91) ***	-0.1276	(-1.02)	-0.2791	(-4.40) ***	-0.0813	(-0.67)	-0.1682	(-1.11)
$Release \times TI\_HFT^D_{t-1}$	0.0829	(1.37)	0.0832	(1.77) *	0.0212	(0.14)	0.2134	(3.95) ***	0.0808	(1.34)	0.0263	(0.30)
$Release \times TI\_HFT^D_{t-2}$	0.0877	(2.33) **	0.0886	(2.34) **	-0.0177	(-0.22)	0.0426	(1.60)	0.0996	(2.31) **	0.0420	(0.58)
$Release \times TI\_HFT^D_{t-3}$	0.0463	(1.25)	0.0518	(1.31)	0.0605	(0.64)	0.0273	(0.95)	0.1167	(2.55) **	0.0799	(1.09)
$Release \times TI\_HFT^D_{t-4}$	-0.0052	(-0.06)	-0.0229	(-0.54)	-0.1092	(-1.03)	-0.0589	(-1.03)	0.0679	(0.54)	-0.1090	(-0.56)
$Release \times TI\_HFT^D_{t-5}$	-0.0044	(-0.06)	0.1163	(1.64) *	-0.0030	(-0.09)	-0.0104	(-0.14)	-0.0758	(-0.50)	-0.0143	(-0.38)
$TI\_Non\text{-}HFT^D_t$	0.5158	(49.57) ***	0.4858	(29.70) ***	0.6662	(16.63) ***	0.5301	(53.64) ***	0.5194	(27.99) ***	0.6751	(18.70) ***
$TI\_Non\text{-}HFT^D_{t-1}$	0.1070	(18.35) ***	0.1143	(10.68) ***	0.1147	(5.53) ***	0.0852	(15.69) ***	0.1011	(8.70) ***	0.1006	(5.76) ***
$TI\_Non\text{-}HFT^D_{t-2}$	0.0170	(3.55) ***	0.0260	(3.64) ***	0.0350	(2.90) ***	0.0113	(2.72) ***	0.0166	(2.57) **	0.0181	(1.65) *
$TI\_Non\text{-}HFT^D_{t-3}$	0.0005	(0.11)	0.0202	(2.80) ***	0.0176	(1.97) **	0.0039	(1.05)	0.0099	(1.84) *	0.0391	(2.87) ***
$TI\_Non\text{-}HFT^D_{t-4}$	-0.0022	(-0.57)	0.0043	(0.66)	0.0040	(0.40)	-0.0018	(-0.51)	0.0247	(2.10) **	0.0047	(0.42)
$TI\_Non\text{-}HFT^D_{t-5}$	-0.0022	(-0.55)	-0.0099	(-1.14)	0.0061	(0.69)	-0.0031	(-0.88)	0.0126	(2.40) **	0.0391	(3.52) ***
$Release \times TI\_Non\text{-}HFT^D_t$	-0.1645	(-2.60) ***	-0.0918	(-0.89)	-0.3712	(-2.04) **	-0.0306	(-0.16)	-0.2905	(-2.74) ***	-0.3794	(-3.23) ***
$Release \times TI\_Non\text{-}HFT^D_{t-1}$	0.0146	(0.29)	-0.0226	(-0.32)	-0.1793	(-1.11)	0.0202	(0.30)	0.0221	(0.25)	0.2311	(1.13)
$Release \times TI\_Non\text{-}HFT^D_{t-2}$	-0.0170	(-0.51)	0.1687	(1.20)	-0.3249	(-1.25)	0.0270	(0.92)	-0.0942	(-0.92)	0.0537	(0.83)
$Release \times TI\_Non\text{-}HFT^D_{t-3}$	0.0252	(0.82)	0.0151	(0.17)	-0.0066	(-0.12)	0.0506	(1.54)	0.0543	(0.40)	-0.1923	(-1.67)
$Release \times TI\_Non\text{-}HFT^D_{t-4}$	0.1863	(2.66) ***	-0.1009	(-0.59)	-0.0026	(-0.10)	0.1045	(2.05) **	0.2575	(1.29)	0.2083	(0.88)
$Release \times TI\_Non\text{-}HFT^D_{t-5}$	-0.1267	(-1.63)	-0.1659	(-1.81) *	-0.1254	(-1.19)	0.0584	(1.14)	-0.1638	(-1.23)	-0.0217	(-0.27)
Obs.	432,720		432,720		411,084		528,880		528,880		502,436	
Adj. R-sq. (%)	12.82		5.72		4.53		13.83		6.26		3.68	

Table 5. The Effects of HFT^D and Non-HFT^D Trade Imbalance on Stock Returns for heterogeneous surprise level

This table presents the pooled OLS regression results for the effects of HFT^D and Non-HFT^D trade imbalance (*TI*) on one-second stock returns. We analyze transaction data in 300-second intervals before and after the announcements from January 1, 2008 to August 31, 2009. Trade imbalance denotes the number of shares in buyer-initiated transactions minus seller-initiated transactions. Trade imbalance for each stock is standardized by the type of investors on each day. The dummy variable *Release* takes the value of 1 for [9:55:00, 9:55:01) and zero otherwise. News surprises of the ICS announcements are defined as the difference between market expectations and the announced values of ICS. The surprise levels are categorized into high, medium and low with the highest tertile corresponding to the large surprise, the middle is the medium surprise, and the lowest is the small surprise. Standard errors are corrected for heteroscedasticity using the White (1980) method. The t-statistics are shown in parentheses next to the coefficients. Here, *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Negative Consumer Sentiment News						Positive Consumer Sentiment News					
	High surprise		Medium surprise		Low surprise		High surprise		Medium surprise		Low surprise	
Intercept	0.0003	(5.69) ***	0.0000	(0.37)	0.0004	(8.48) ***	0.0005	(9.55) ***	-0.0001	(-1.56)	0.0001	(2.75) ***
$TI\_HFT^D_t$	0.5349	(22.92) ***	0.6011	(15.22) ***	0.4560	(22.40) ***	0.5558	(24.75) ***	0.6256	(23.18) ***	0.5486	(26.97) ***
$TI\_HFT^D_{t-1}$	0.1149	(9.26) ***	0.0818	(6.44) ***	0.1090	(10.79) ***	0.1081	(9.53) ***	0.1103	(7.85) ***	0.0878	(8.71) ***
$TI\_HFT^D_{t-2}$	0.0335	(3.14) ***	0.0268	(3.62) ***	0.0217	(2.79) ***	0.0307	(4.04) ***	0.0323	(2.99) ***	0.0276	(1.54)
$TI\_HFT^D_{t-3}$	0.0230	(2.63) ***	0.0180	(2.31) **	0.0023	(0.40)	0.0113	(1.47)	0.0049	(0.65)	0.0048	(0.94)
$TI\_HFT^D_{t-4}$	0.0132	(2.14) **	-0.0013	(-0.24)	0.0093	(1.72) *	0.0109	(1.70) *	0.0136	(1.74) *	0.0020	(0.52)
$TI\_HFT^D_{t-5}$	0.0159	(2.16) **	0.0048	(0.73)	0.0062	(1.09)	0.0029	(0.44)	0.0081	(0.92)	0.0001	(0.03)
$Release \times TI\_HFT^D_t$	-0.1296	(-1.75) *	-0.4085	(-6.89) ***	-0.3378	(-5.59) ***	-0.1957	(-2.76) ***	-0.0976	(-0.48)	-0.1386	(-1.33)
$Release \times TI\_HFT^D_{t-1}$	0.0446	(0.82)	0.1419	(2.01) **	-0.0085	(-0.13)	0.1246	(2.53) **	0.1091	(1.74) *	-0.0225	(-0.17)
$Release \times TI\_HFT^D_{t-2}$	0.0765	(2.58) ***	0.1367	(1.65) *	-0.0549	(-1.33)	0.1668	(3.14) ***	-0.0001	(0.00)	0.0304	(0.96)
$Release \times TI\_HFT^D_{t-3}$	0.0312	(1.15)	0.2027	(5.45) ***	-0.0363	(-1.15)	0.0979	(1.53)	0.0078	(0.30)	0.1520	(3.58) ***
$Release \times TI\_HFT^D_{t-4}$	-0.6324	(-1.46)	0.0074	(0.18)	0.1376	(0.82)	0.0676	(0.77)	-0.0722	(-1.28)	-0.2745	(-1.54)
$Release \times TI\_HFT^D_{t-5}$	0.0834	(0.89)	0.0704	(0.93)	-0.0575	(-0.81)	-0.0937	(-0.90)	0.1219	(1.40)	0.0195	(0.30)
$TI\_Non\text{-}HFT^D_t$	0.5632	(23.35) ***	0.5535	(19.72) ***	0.5507	(23.98) ***	0.6128	(21.99) ***	0.5701	(27.05) ***	0.5422	(25.91) ***
$TI\_Non\text{-}HFT^D_{t-1}$	0.1099	(8.00) ***	0.1144	(7.04) ***	0.1089	(10.76) ***	0.0863	(7.06) ***	0.1070	(10.01) ***	0.0906	(6.54) ***
$TI\_Non\text{-}HFT^D_{t-2}$	0.0255	(3.09) ***	0.0205	(2.10) **	0.0292	(4.12) ***	0.0043	(0.45)	0.0203	(2.93) ***	0.0169	(2.64) ***
$TI\_Non\text{-}HFT^D_{t-3}$	0.0101	(1.35)	0.0095	(1.53)	0.0155	(2.07) **	0.0079	(0.92)	0.0185	(2.41) **	0.0235	(2.52) **
$TI\_Non\text{-}HFT^D_{t-4}$	-0.0021	(-0.32)	-0.0002	(-0.03)	0.0064	(0.82)	0.0041	(0.55)	0.0126	(1.31)	0.0073	(0.66)
$TI\_Non\text{-}HFT^D_{t-5}$	-0.0068	(-0.82)	0.0009	(0.13)	-0.0019	(-0.29)	0.0140	(2.37) **	0.0224	(2.70) ***	0.0090	(1.24)
$Release \times TI\_Non\text{-}HFT^D_t$	-0.2490	(-2.89) ***	-0.1425	(-1.59)	-0.0574	(-0.60)	-0.3289	(-2.49) **	-0.2285	(-1.76) *	-0.1538	(-1.03)
$Release \times TI\_Non\text{-}HFT^D_{t-1}$	-0.0334	(-0.56)	0.0297	(0.58)	0.0071	(0.08)	0.2538	(1.51)	0.0637	(0.80)	-0.0258	(-0.53)
$Release \times TI\_Non\text{-}HFT^D_{t-2}$	-0.0216	(-0.47)	0.1068	(1.51)	-0.0248	(-0.38)	-0.0625	(-0.95)	0.0130	(0.35)	0.0551	(0.99)
$Release \times TI\_Non\text{-}HFT^D_{t-3}$	0.0057	(0.20)	0.1410	(1.74) *	0.0460	(0.89)	0.0476	(0.64)	-0.0610	(-1.59)	-0.0405	(-0.67)
$Release \times TI\_Non\text{-}HFT^D_{t-4}$	-0.0468	(-0.25)	0.1276	(1.77) *	-0.0127	(-0.37)	0.1199	(1.54)	-0.0390	(-0.63)	0.4857	(1.06)
$Release \times TI\_Non\text{-}HFT^D_{t-5}$	-0.1845	(-1.40)	-0.1405	(-1.54)	-0.0460	(-0.74)	-0.1360	(-1.17)	0.0864	(2.48) **	-0.0627	(-0.82)
Obs.	425,508		425,508		425,508		496,426		496,426		567,344	
Adj. R-sq. (%)	6.04		6.74		6.70		6.05		5.78		6.59	

Table 6. Trading Profits of Liquidity-Demanders and Liquidity-Suppliers for HFTs and Non-HFTs

This table presents results on HFTs and non-HFTs' trading profits. Profits are calculated for liquidity-demanders (Panel A) and liquidity-suppliers (Panel B). HFT^D (HFT^S) and $Non\text{-}HFT^D$ ($Non\text{-}HFT^S$) denote liquidity-demanding (supplying) HFT and non-HFT, respectively. We analyze transaction data on ICS announcement days from January 1, 2008 to August 31, 2009. The column "Open position" denotes the timing of buy or sell transactions during the advance peek on ICS such that 9:54:58 (9:54:59) denotes two (one) seconds before the ICS announcements at 9:55:00 a.m. We assume traders close their positions at various times from 9:55:00 a.m. to 9:56:00 a.m. Settlement price for closing a position is represented by the average price at the time of closing out the position. If no price occurs at that time, we employ the last close price for that stock. The numbers of investors for HFT and Non-HFT originate from 26 high frequency trading firms and the remaining market participants, respectively.

	Close position							
Open position	9:55:00	9:55:01	9:55:02	9:55:03	9:55:04	9:55:05	9:55:30	9:56:00
Panel A: Liquidity-demanders								
HFT^D								
9:54:58	33,826	35,700	37,747	39,700	41,637	41,484	14,980	7,996
9:54:59	5,017	6,049	6,836	5,726	6,362	5,768	-4,178	-7,046
$Non\text{-}HFT^D$								
9:54:58	30,704	33,107	34,901	35,968	36,352	36,224	10,707	8,594
9:54:59	-283	207	283	501	619	459	179	-1,374
	Close position							
Open position	9:55:00	9:55:01	9:55:02	9:55:03	9:55:04	9:55:05	9:55:30	9:56:00
Panel B: Liquidity-suppliers								
HFT^S								
9:54:58	-27,213	-28,818	-30,685	-31,420	-33,356	-33,464	-11,125	-8,185
9:54:59	-756	-1,184	-1,156	-566	-1,172	-1,041	713	344
$Non\text{-}HFT^S$								
9:54:58	-37,343	-40,014	-41,988	-44,274	-44,659	-44,269	-14,587	-8,430
9:54:59	-4,019	-5,112	-6,004	-5,703	-5,851	-5,227	3,245	8,035

Table 7. Return and Trade Characteristics for ICS and New Home Sales Announcements for S&P 500 ETFs

This table presents mean difference tests of return, volume and trade imbalance on ICS announcement days. The advance peek on ICS occurred at 09:54:58 EST during the sample period from January 1, 2008 to August 31, 2009. For the period January 1, 2004 – December 31, 2006, the University of Michigan published the ICS data at 10:00am. When the value for the ICS is higher (lower) than the median forecast from the Thomson Reuters Survey of Economists, it is regarded as positive (negative) consumer sentiment news. We compute the average one-second interval stock return, trade volume, and trade imbalance from 9:54:58 to 9:55:00 and from 9:55:00 to 9:55:02. Returns are defined as the first difference of the log of stock price calculated from NBBO quotes, volatility is measured by the absolute return, trading volume is measured by the number of shares traded, and trade frequency is defined as the average number of trades per second. ICS announcement days are ICS announcement Fridays. Results for ICS announcements are in Panels A to C whilst those for new home sales announcements are in Panels D to F. The superscripts *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Negative Consumer Sentiment News			**Positive Consumer Sentiment News**		
	9:59:58 - 10:00:00	10:00:00 - 10:00:02	t stat.	9:59:58 - 10:00:00	10:00:00 - 10:00:02	t stat.
Panel A: Jan. 2004-Dec. 2006						
Return (%)	-0.0003	-0.0001	(-0.33)	0.0005	0.0001	(0.90)
Volatility	0.0014	0.0020	(-1.26)	0.0014	0.0009	(0.93)
Volume	1,081.58	768.42	(0.70)	491.178	1,150.00	(-1.19)
Trade frequency	3.78	2.58	(0.70)	1.19	2.21	(-0.96)
	9:54:58 - 9:55:00	9:55:00 - 9:55:02	t stat.	9:54:58 - 9:55:00	9:55:00 - 9:55:02	t stat.
Panel B: Jan. 2008-Jun. 2013						
Return (%)	-0.0183	-0.0016	(-4.87) ***	0.0157	0.0007	(6.08) ***
Volatility	0.0211	0.0068	(4.42) ***	0.0193	0.0076	(5.37) ***
Volume	32,092.48	8,681.37	(4.23) ***	25,520.20	7,793.55	(3.57) ***
Trade frequency	56.91	16.81	(5.01) ***	41.73	15.65	(4.84) ***
Panel C: Jul. 2013-Dec. 2014						
Return (%)	-0.00002	-0.0030	(2.83) ***	0.0003	0.0019	(-1.64)
Volatility	0.0008	0.0039	(-3.32) ***	0.0019	0.0029	(-1.31)
Volume	1,337.03	4,938.19	(-2.32) **	1012.94	4396.14	(-2.47) **
Trade frequency	3.56	13.36	(-3.60) ***	4.38	9.00	(-0.80)
	Negative New Home Sales News			**Positive New Home Sales News**		
	9:59:58 - 10:00:00	10:00:00 - 10:00:02	t stat.	9:59:58 - 10:00:00	10:00:00 - 10:00:02	t stat.
Panel D: Jan. 2004-Dec. 2006						
Return (%)	-0.0001	-0.0001	(0.13)	-0.0002	0.0009	(-1.94) **
Volatility	0.0006	0.0001	(1.24)	0.0004	0.0013	(-1.68) *
Volume	1268.75	159.38	(1.42)	457.50	1162.50	(-0.95)
Trade frequency	2.88	0.34	(1.58)	2.53	2.35	(0.11)
Panel E: Jan. 2008-Jun. 2013						
Return (%)	-0.0005	-0.0284	(5.09) ***	0.0036	0.0253	(-3.51) ***
Volatility	0.0066	0.0329	(-5.19) ***	0.0068	0.0324	(-4.63) ***
Volume	3,705.81	28,664.66	(-5.67) ***	6,722.19	33,094.55	(-4.77) ***
Trade frequency	8.05	54.09	(-6.71) ***	9.66	59.05	(-6.48) ***
Panel F: Jul. 2013-Dec. 2014						
Return (%)	0.0002	-0.0046	(1.28)	-0.0017	0.0092	(-2.04) *
Volatility	0.0016	0.0104	(-3.05) ***	0.0017	0.0118	(-2.08) *
Volume	1,233.56	14,236.94	(-2.86) **	568.42	10,038.00	(-2.68) **
Trade frequency	6.17	45.67	(-3.15) ***	1.83	25.50	(-2.84) **

Table 8. Difference-in-Difference Analysis for S&P 500 ETFs (January 2004 - December 2014)

This table presents difference-in-difference tests of return, volume and trade imbalance on ICS announcement and non-ICS announcement days. The advance peek on ICS occurred at 09:54:58 EST during the sample period from January 1, 2008 to August 31, 2009. When the value for the ICS is higher (lower) than the median forecast from the Thomson Reuters Survey of Economists, it is regarded as positive (negative) consumer sentiment news. We compute the average one-second interval stock return, trade volume, and trade imbalance from 9:54:58 to 9:55:00 and from 9:55:00 to 9:55:02. Returns are defined as the first difference of the log of stock price calculated from NBBO quotes, volatility is measured by the absolute return, trading volume is measured by the number of shares traded, and trade frequency is defined as the average number of trades per second. ICS announcement days are ICS announcement Fridays. The difference-in-difference analysis involves two stages. In the first stage, we compute the difference in the variable of interest for the period (9:54:58-9:55:00) and (9:55:00-9:55:02). In the second stage, we test the difference in the variable of interest between the two consecutive periods, namely period 1 and period 2 as reported in Panel A, and period 2 and period 3 as reported in Panel B. Results for new home sales announcements are reported in Panels C and D. The superscripts *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

	Negative Consumer Sentiment News			**Positive Consumer Sentiment News**		
Panel A: Testing for the Difference between sub-period 1(2004/01-2006/12) and sub-period 2 (2008/01-2013/06)						
	Sub-period 1:	Sub-period 2:	t stat.	Sub-period 1:	Sub-period 2:	t stat.
Return (%)	-0.0002	-0.0167	5.19 ***	0.0005	0.0150	-6.77 ***
Volatility	-0.0007	0.0143	-5.13 ***	0.0004	0.0117	-5.90 **
Volume	313.16	23,411.11	-4.30 ***	-658.82	17,726.65	-4.01 ***
Trade frequency	1.20	40.10	-5.01 ***	-1.01	26.08	-5.63 ***
Panel B: Testing for the Difference between sub-period 2 (2008/01-2013/06) and sub-period 3 (2013/07-2014/12)						
	Sub-period 2:	Sub-period 3:	t stat.	Sub-period 2:	Sub-period 3:	t stat.
Return (%)	-0.0167	0.0029	-6.06 ***	0.0150	-0.0015	7.32 ***
Volatility	0.0143	-0.0031	5.74 ***	0.0117	-0.0010	6.29 **
Volume	23,411.11	-3,601.17	4.77 ***	17,726.65	-3,383.19	4.47 ***
Trade frequency	40.10	-9.36	5.84 ***	26.08	-9.08	6.05 ***

	Negative New Home Sales News			**Positive New Home Sales News**		
Panel C: Testing for the Difference between sub-period 1(2004/01-2006/12) and sub-period 2 (2008/01-2013/06)						
	Sub-period 1:	Sub-period 2:	t stat.	Sub-period 1:	Sub-period 2:	t stat.
Return (%)	0.0001	0.0279	-4.99 ***	-0.0011	-0.0217	3.21 ***
Volatility	0.0005	-0.0263	5.66 ***	-0.0009	-0.0256	4.44 ***
Volume	1,109.38	-24,958.85	6.61 ***	-705.00	-26,372.36	5.84 ***
Trade frequency	2.53	-46.04	6.17 ***	0.18	-49.40	4.49 ***
Panel D: Testing for the Difference between sub-period 2 (2008/01-2013/06) and sub-period 3 (2013/07-2014/12)						
	Sub-period 2:	Sub-period 3:	t stat.	Sub-period 2:	Sub-period 3:	t stat.
Return (%)	0.0279	0.0047	3.38 ***	-0.0217	-0.0109	-1.24
Volatility	-0.0263	-0.0089	-3.29 ***	-0.0256	-0.0101	-2.22 **
Volume	-24,958.85	-13,003.39	-0.45	-26,372.36	-9,469.58	-2.39 **
Trade frequency	-46.04	-39.50	-1.98 *	-49.40	-23.67	-2.66 **