The Dynamic Impact of Anonymity on Unsophisticated Liquidity under Changing Information Asymmetry

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Yijie Li

Aalto University School of Business

PO BOX 21220

FI-00076 AALTO

FINLAND

Email: yijie.li@aalto.fi

Abstract

This paper finds that in Nasdaq Helsinki where brokers can voluntarily reveal or conceal identities, unsophisticated traders are less willing to trade after anonymous trades than non-anonymous trades. Using intraday order and trade data of large-cap stocks to which the voluntary anonymity model applies, I find that on earnings announcement days, the duration-until-next-unsophisticated-order (*DUNUO*) —a novel unsophisticated liquidity measure—following an anonymous trade is 21 seconds longer than that following a non-anonymous trade before announcements. However, this difference reduces to 8 seconds when earnings information is disclosed, implying a reduction in the negative impact of anonymity caused by lower information asymmetry. Moreover, unsophisticated traders are found to be increasingly unwilling to trade as the degree of anonymity—whether the preceding trade is non-, half-, or fully anonymous—increases.

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1 Introduction

Trader anonymity refers to brokers intermediating trading on behalf of investors anonymously pre- and/or post-trade, preventing themselves and the type of their clients from being identified by other market participants. This paper studies the impact of anonymity on a particular group of market participants—the unsophisticated investors—and examines whether this impact varies under changing information asymmetry. Using a trade-level unsophisticated liquidity measure—duration-until-next-unsophisticated-order (*DUNUO*), I compare unsophisticated traders' willingness to trade after anonymous trades and non-anonymous trades, and their difference is considered as the impact of anonymity on unsophisticated liquidity.

As of March 24, 2014, Nasdaq Nordic introduced a new post-trade voluntary anonymity model for large-cap stocks on the Copenhagen, Helsinki, and Stockholm stock exchanges. Under the new model, brokers can choose on a monthly basis whether their identities are shown in public feed in real time. This unique natural experiment enables an intraday-level investigation of the reactions of unsophisticated traders who are faced with anonymous or non-anonymous trades using *DUNUO*.

As the most uninformed group of investors, unsophisticated investors and the liquidity provided by them have largely been overlooked in previous empirical studies regarding anonymity. They have drawn little attention due to three reasons: 1) unsophisticated investors possess less equities and their trade sizes are smaller compared with sophisticated investors, which are usually institutions or wealthy individuals (e.g. Lee and Radhakrishna, 2000; Malmendier and Shanthikumar, 2007); 2) unsophisticated investors are expected to be intrinsically naive (e.g. Malmendier and Shanthikumar, 2007); and 3) there was no clear way to measure unsophisticated liquidity in the real market. Earlier studies (e.g., Bloomfield, O'Hara, and Saar, 2009; Bloomfield, Tayler, and Zhou, 2009) only use a laboratory market to study the trading of investors who lack informational advantages.

In practice, unsophisticated traders serve an important role in limit order equity markets as both liquidity providers and demanders. For example, in the case of Kone, an international engineering and service company and one of the largest public firms on Nasdaq Helsinki, 26.8% of the submitted orders that turned into trades on April 23, 2014 were attributed to unsophisticated traders. Similarly, in the case of YIT, which provides building, construction, and maintenance services and is one of the smallest large-cap firms on Nasdaq Helsinki, 39.2% of the orders that turned into trades on February 22, 2016 were submitted by unsophisticated traders.[1] The role played by unsophisticated traders as trade counterparties are negligible in studies about equity market liquidity.

The contributions of this paper to the literature about the impact of trader anonymity on market liquidity are two-fold. First, this paper provides direct evidence on the effect of anonymity on unsophisticated liquidity at an intraday level, thanks to the voluntary post-trade anonymity model enacted on Nasdaq Helsinki. This special market design resembles to the one investigated by Comerton-Forde, Putnins, and Tang (2011), which documents who and why they trade anonymously. Like their paper, this study circumvents the endogenous variations in market structures and quality accompanying the prior studies that concerns either 1) the one-off improvement or deterioration of liquidity caused by an anonymity reform; or 2) the liquidity difference between markets with different degrees of transparency.[2]

Madhavan and Cheng (1997) suggest that anonymity can reduce uninformed liquidity when traders cannot prove that their trades are not information-based. In this regard, anonymity should negatively affect unsophisticated liquidity. This is because when unsophisticated traders observe

[1] Both example dates are the firms' earnings announcement days.

[2] Studies utilizing one-off market anonymity reforms cover almost all of the major stock exchanges in the world, including Nasdaq (Benhami, 2006), Tokyo Stock Exchange (Comerton-Forde, Frinos, and Mollica, 2005), London Stock Exchange (Freiderich and Payne, 2014), Toronto Stock Exchange (Comerton-Forde, Putnins, and Tang, 2011), Paris Bourse (Comerton-Forde, Frinos, and Mollica, 2005; Foucault, Moinas, and Theissen, 2007), Frankfurt Stock Exchange (Hachmeister and Schiereck, 2010), Australian Stock Exchange (Comerton-Forde and Tang, 2009), Korea Stock Exchange (Comerton-Forde, Frinos, and Mollica, 2005), Stockholm Stock Exchange (Dennis and Sandås, 2016), and Helsinki Stock Exchange (Dennis and Sandås, 2016). Studies that compare the liquidity difference across markets include those of Garfinkel and Nimalendran (2003); Gramming, Schiereck, and Theissen (2001); Madhaven and Cheng (1997); and Reiss and Werner (2004).

anonymous trades in real time, it is difficult for them to gauge whether these trades are information-based or liquidity-motivated, so they may postpone their order submissions to wait for more information or even change their trading plans. Using a comprehensive set of order messages and trade records of 14 large-cap stocks on Nasdaq Helsinki between April 2014 and December 2017, which involves 115 earnings announcement days, I find that *DUNUO* after anonymous trades is significantly longer than *DUNUO* after non-anonymous trades, suggesting that trader anonymity has a negative impact on unsophisticated liquidity.

The second contribution of this paper is that it provides direct empirical evidence of the effect of information asymmetry on the relationship between anonymity and unsophisticated liquidity. The impact of information asymmetries on the anonymity-liquidity relationship has been studied by Foucault, Moinas, and Theissen (2007), who show *theoretically* that when the degree of information asymmetries is high (low), anonymity imposes a negative (positive) impact on liquidity. Comerton-Forde and Tang (2009) provide empirical evidence of cross-sectional variations of the impact of anonymity on liquidity due to different levels of information asymmetries across stocks, supporting Foucault, Moinas, and Theissen's (2007) prediction. This paper, however, presents time-series variations of the impact of anonymity caused by the variation of information asymmetries, that is, the negative impact of anonymity on unsophisticated liquidity becomes smaller when information asymmetries perceived by unsophisticated traders decline.

Based on the intuition that information disclosure resolves uncertainty and the empirical evidence that information asymmetry is lower after earnings announcements (e.g., Duarte, Hu, and Young, 2017; Johnson and So, 2017; Lee, Mucklow, and Ready, 1993; Lof and van Bommel, 2017), I utilize the disclosure of earnings information to capture a decline of information asymmetries. To give a brief idea, Figure 1 shows the variations of *DUNUO* and the difference between *DUNUO* after anonymous trades and *DUNUO* after non-anonymous trades around earnings announcements. The overall level of *DUNUO* is clearly higher before than after announcements, implying a negative

association between information asymmetry and unsophisticated liquidity. The average *DUNUO* reaches its highest point, 56.4 seconds, during the hour before announcements and drops to its lowest point, 8.4 seconds, during the hour after announcements, and then increases gradually. The same pattern applies to the difference between *DUNUO* after anonymous trades and *DUNUO* after non-anonymous trades: the difference is highest right before announcements (23.7 seconds) and lowest right after announcements (4.2 seconds). This pattern suggests a reduction in the negative impact of anonymity on unsophisticated liquidity following information disclosure. Regression results support the patterns revealed in Figure 1.

[INSERT FIGURE 1]

To further investigate unsophisticated traders' reactions to trader anonymity, I examine whether trader anonymity affects unsophisticated liquidity providers and demanders differently and whether unsophisticated traders' sensitiveness increases with the degree of anonymity. The finding regarding the first question is that before announcements unsophisticated liquidity providers are more sensitive to anonymity than demanders, but the negative impacts of anonymity on the two types of unsophisticated traders diminish to a similar level after announcements. As for the second question, I categorize trades into a fully anonymous group, a half-anonymous group, and a non-anonymous group and find that *DUNUO* is longest after fully anonymous trades and shortest after non-anonymous trades. Additionally, the negative impact of fully anonymous trades decreases more after information disclosure than that of half-anonymous trades.

Another contribution of this paper is that, to the best of my knowledge, this is the first study that measures unsophisticated liquidity using the duration between a trade and its following unsophisticated order. This measure disentangles the impact of anonymity on unsophisticated traders from the overall impact based on the assumption that unsophisticated traders observe and react to recent trades in the market. This assumption is rigorous as it requires unsophisticated investors base their order submissions on the information contained in the latest trade within seconds. Sometimes,

traders may only see earlier trades rather than the latest one due to a delayed update of trade feeds or the fact that order submission takes time. Therefore, I calculate the average durations from a trade to the following 5 and 10 unsophisticated orders and find that the average durations are highly correlated with *DUNUO*. Then I conduct the same regression analyses using the average durations and obtain similar results.

One other potential problem of using *DUNUO* to measure unsophisticated liquidity is that it may be highly correlated with trading activity. The variation of *DUNUO* around earnings announcements shown in Figure 1 coincides with the pattern of trading activity around earnings announcements revealed by earlier studies (e.g. Lee, Mucklow, and Ready, 1993). To test whether the variation of *DUNUO* is driven by the variation of trading activity, I control for the logarithm of the number of trades during the relevant trading hour and find no change in my findings.

Furthermore, to rule out the possibility that the findings of this paper are subject to the use of *DUNUO*, I compare *DUNUO* with an alternative unsophisticated liquidity measure—the proportion of unsophisticated orders following a trade—and examine how the alternative measure is affected by trader anonymity when the level of information asymmetries declines. The alternative unsophisticated liquidity measure is found to be negatively affected by anonymity and this negative effect reduces after announcements.

The remainder of this paper is organized as follows. Section 2 briefly introduces Nasdaq Helsinki and the voluntary post-trade visibility model. Section 3 reviews previous findings about the level of information asymmetries around earnings announcements. Section 4 presents the sample and data. Section 5 describes the empirical models and presents the main results. Section 6 investigates unsophisticated traders' various reactions to anonymity depending on their own type and the degree of anonymity. Section 7 provides robustness tests. Section 8 concludes.

2 The Nasdaq Helsinki Stock Exchange and Voluntary Anonymity

In this section, I present the institutional setting of Nasdaq Helsinki and the voluntary post-trade visibility model, which enables the investigation of the anonymity-liquidity relationship in a single market at an intraday level. The use of this market avoids the potential confounding factors associated with one-off market reforms, which widely affects the previous studies in this field.

2.1 Institutional Setting

Nasdaq Helsinki, one of the market segments of Nasdaq Nordic, is the Finnish local exchange facilitating the transactions of shares, warrants, certificates, exchange-traded notes, equity rights, investment fund units, and exchange-traded funds. The trading of stocks in Finland is concentrated on this market.[3] Like other equity segments of Nasdaq Nordic, Nasdaq Helsinki is traded on Nasdaq's INET Nordic trading platform. It is an order-driven market in which buyers and sellers reveal the price at which they would like to buy or sell a certain amount of a stock by submitting orders to the exchange during the continuous trading hours. The order can be a limit order, which is added to the existing order book when its quote is worse than the best opposite-side quote and waits to be matched, or a market order, which fulfills one or more existing opposite-side orders thus being executed immediately. The continuous trading session of Nasdaq Helsinki is between 10:00 a.m. and 6:25 p.m. local time. On trading days, there is a scheduled intraday call between 2:30 p.m. and 2:35 p.m. during which continuous trading is not possible. Except for the scheduled intraday call period, orders are automatically matched following the price-internal-display-time priority.[4]

2.2 Voluntary Post-Trade Visibility Model

[3] By the end of July 2018, there were 135 stocks publicly traded on Nasdaq Helsinki, among which 36 stocks have a market capitalization no less than EUR 1 billion and are thus categorized as large-cap stocks.
[4] Starting on November 16, 2015, trades and orders in Nasdaq Nordic have been time-stamped in nanosecond instead of microsecond resolution.

Trades executed on Nasdaq Helsinki are published in real time on the public trade ticker. Each trade feed contains information such as transaction price, volume, timestamp, and participants' identifiers. After March 24, 2014, the voluntary post-trade visibility model came into effect for the current and former large-cap and main index shares on Nasdaq Copenhagen, Helsinki, and Stockholm. This anonymity model allows brokers to voluntarily choose whether their identities are disclosed or concealed in real time by notifying Nasdaq Nordic on a monthly basis. A change of visibility is valid from the beginning of the month following the notice. The decision can be made separately for each of the previously mentioned exchanges, whereas stock-level decisions are not possible.

Even though this visibility model is not flexible enough for brokers to switch between being anonymous and being transparent when their needs change, the real traders, especially the sophisticated traders, may use multiple brokers and choose between anonymous and non-anonymous brokers strategically. However, the endogenous broker choice is less of a concern given the evidence in Linnainmaa and Saar (2012) that multi-broker usage is insufficient.

Moreover, traders in Nasdaq Helsinki cannot benefit much from using non-anonymous brokers to improve the likelihood of their orders being executed when unsophisticated liquidity is low because the identities of brokers other than market makers are concealed pre-trade in this market.[5] The traders who possess private information may prefer to use anonymous brokers when the information asymmetry risk is great, but this will not be a problem if the effect of anonymity on unsophisticated liquidity does not vanish when the level of information asymmetry is controlled for.

[5] Market makers can choose to use the Market Maker Order (MMO) that is flagged in the public market data feeds pre-trade (see the Nasdaq Nordic Market Model, 2017).

3 Earnings Announcements and Information Asymmetry

The degree of information asymmetries between sophisticated traders who are more likely to be informed and unsophisticated traders who are typically uninformed varies constantly. This variation can be significant when informative corporate events such as earnings announcements occur. Because earnings announcements resolve uncertainty in the stock market, the degree of information asymmetries is expected to be higher before than after announcements.

Earlier studies including Kim and Verrecchia (1994, 1997) predict that information asymmetries are higher after than before earnings announcements because some agents can produce informed judgments from public announcements, which exacerbate information asymmetries in the market. Some studies provide supporting evidence by showing that measures of information asymmetry are higher after than before announcements. Among these, Benos and Jochec (2007) and Back, Crotty, and Li (2017) use the PIN measure—the probability of informed trading developed by Easley, Kiefer, O'Hara, and Paperman (1996)—or measures based on PIN to proxy informed trading, whereas Krinsky and Lee (1996) employ the adverse selection cost component of the bid-ask spreads to capture the degree of information asymmetries.[6]

However, according to recent studies, the findings about higher information asymmetry after announcements are subject to the use of certain measures. The PIN and PIN-based measures are found to capture not only informed trading but also abnormal turnovers. Kim and Verrecchia (1994) theoretically predict that trading volume after announcements positively depends on the degree of information asymmetries, but Duarte, Hu, and Young (2017) point out that turnover changes can be caused by various reasons unrelated to private information, including disagreement, calendar effects, portfolio rebalancing, and taxation. Moreover, spreads-based measures may capture factors other than

[6] Other studies that discovered a higher level of information asymmetries measured by the PIN after than before public news announcements (e.g., M&A announcements, SEO initiations, dividend initiations) include those of Aktas, de Bodt, Declerck, and Van Oppens (2007) and Brennan, Huh, and Subrahmanyam (2017).

informed trading as well. Chordia, Roll, and Subrahmanyam (2000) argue that trading volume affects bid-ask spreads of individual stocks, and empirically show that trading frequency and volume of individual stocks have a strong positive impact on their spreads. Furthermore, Collin-Dufresne and Fos (2015) investigate whether the prevalent measures of adverse selection, including PIN, realized spread, and effective spread, capture information asymmetry, and draw a negative conclusion.

In addition to the debate regarding PIN and spreads as valid measures of information asymmetry, many recent studies provide direct evidence that the level of information asymmetries is lower after than before earnings announcements using adjusted PIN measures or new measures of information asymmetry that are not subject to the conflation of volume with private information (e.g., Duarte, Hu, and Young, 2017; Easley, Engle, O'Hara, and Wu, 2008; Johnson and So, 2017; Lof and van Bommel, 2017).[7]

At the intraday level, Lee, Mucklow, and Ready (1993) find that liquidity measures after earnings announcements are not significantly different from their nonevent period averages after controlling for trading volume. Considering the weak relation between trading volume and private information, this finding suggests that the information asymmetry risk after announcements is not higher than during nonevent periods. Given this evidence, I relate the period right before announcements to a high information asymmetry risk and the period right after announcements to a low information asymmetry risk.

[7] Duarte, Hu, and Young (2017) examine two extensions of the PIN model; Easley, Engle, O'Hara, and Wu (2008) develop a dynamic model to forecast the arrival rates of informed and uninformed traders and a time series of generalized PINs using shorter periods; Johnson and So (2017) create a multimarket information asymmetry (MIA) measure to capture the abnormal volume generated by informed traders in option and stock markets; and Lof and van Bommel (2017) develop the new measure volume coefficient variation (VCV) for information asymmetry, which is easily computable and avoids the potential problems of the PIN measure.

4 Data and Sample

The sample period of this study is from April 2014 to December 2017. The raw data consist of the intraday order-level data and the end-of-day transaction records of 14 current and former large-cap and main index shares on Nasdaq Helsinki, for which voluntary post-trade anonymity is allowed according to the Nasdaq Nordic Market Model (2017), on 115 stock-unique earnings announcement days. In the following part of this section, I introduce the variables of interest.

4.1 ITCH Data and Trader Anonymity

4.1.1 Nordic Equity TotalView ITCH

To obtain information about which trades are anonymous in real time, I collect the Nordic Equity TotalView ITCH data from Nasdaq Helsinki. ITCH data are a set of stock market order-level messages that record all changes in an order book (except for actions related to non-displayable orders). These messages include order-level data with attributions, trade messages, net order imbalance data, administrative messages, and event control messages. Trade participants' identities are revealed, in case they trade non-anonymously, in trade feeds in real time to brokers and traders who have access to the Nordic Equity TotalView.[8] Typically, unsophisticated investors can access trade feeds via the trading platforms they use.

Order-level data with attributions include add order messages, order cancel messages, and order delete messages. Each add order message creates a unique order reference number and consists of information such as the timestamp, price, volume, and direction of order (buy or sell). Order cancel messages and order delete messages record a reduction in trade volume of an existing order and a deletion of an entire order, respectively.

[8] Investors can access the Nordic Equity TotalView directly from Nasdaq, via market data vendors (such as Bloomberg, Morningstar, Thomson Reuters, and dozens of other institutions), or through distributors of market data feeds.

Trade messages contain two major types of trades: executions of existing orders (*type I*) and executions involving non-displayable orders (*type II*).[9] A *type I* trade message contains the reference number of the existing order that has been matched in execution. Following a *type I* trade, the volume of the existing order is reduced by the trade volume. The existing order stays on the order book until it is deleted or its volume left unmatched reaches zero. On the contrary, because non-displayable orders are never added to the order book, a *type II* trade message has no effect on the existing order book. Both types of trade messages provide information including trade identifier, timestamp, volume, and identifiers of the trade participants.[10]

If trade participants—mostly brokers who act on behalf of traders—voluntarily choose to be visible after executions in real time, their identities will be shown in trade messages together with other information of those trades. In contrast, anonymous traders' identities are not revealed in trade messages but can be identified using the end-of-the-day transaction records, which are provided by Nasdaq Helsinki separately on a yearly basis. Because transaction records also contain trade identifiers, each ITCH trade message can be matched with a transaction record. This enables the identification of anonymous traders in the ITCH data.

4.1.2 Trade Anonymity

I define a trade as anonymous if either participant of the trade is anonymous.[11] If both participants are visible in an ITCH trade message, the trade is considered non-anonymous. Following this rule, I construct a dummy variable, *Anonymity*, which is 1 for anonymous trades and 0 for non-anonymous trades. Table 1 shows that contrary to Comerton-Forde, Putnins, and Tang (2011)'s finding but

[9] In the Nasdaq Nordic Equity TotalView ITCH manual (2011, 2017), *type I* trade messages are called order execution messages and belong to order-level data with attributions, as they change the existing order book. For ease of understanding and reference, I categorize them as a type of trade messages in this paper.

[10] Participants of trades in Nasdaq Helsinki are brokers rather than real traders. Although other market participants cannot observe the identity of the real traders, Linnainmaa and Saar (2012) show that to some extent, others can tell the type (informed or uninformed) of the real investors based on their brokers' identity.

[11] Alternative definitions of trade anonymity are explored in section 6 for the investigation of unsophisticated traders' reactions to different degrees of anonymity.

consistent with earlier literature that suggests liquidity being attracted to anonymous markets (e.g. Bloomfield and O'Hara, 2000; Madhavan, 1995; Grossman, 1992), most of the sample trades are anonymous. On the 115 stock-unique sample earnings announcement days, 91.4% of trades involve at least one anonymous trader.[12] Table 1 also reports that the percentage of anonymous trades is greater before than after announcements by 3%. This difference is statistically significant and it implies that anonymous trades are preferable when private information is more likely to exist. In addition, Table 1 shows that traders are more reluctant to trade before announcements: the average number of trades per hour surges by 154% following the disclosure of earnings information.

[INSERT TABLE 1]

4.2 Indicator of the Level of Information Asymmetries

In this paper, I collect the publication timestamps of earnings announcements during the sample period and split each of the sample announcement days into a pre-announcement and a post-announcement period using these timestamps. For each of the recorded trades on the sample announcement days, a dummy variable, *Disclosure*, is created, which equals 0 if a trade occurs during the pre-announcement period and 1 otherwise. Based on the discussion about information asymmetries around earnings announcements in section 3, this dummy serves as an indicator of the level of information asymmetries.

The source of the earnings announcement timestamps is Nasdaq GlobeNewswire.[13] Because earnings announcements are made along with quarterly reports, I manually collect the publication timestamps of these reports. To avoid confounding factors that occur outside of continuous trading hours and allow for sufficient observations in both the pre- and post-announcement periods, I exclude

[12] The 115 earnings announcements in the sample all occurred during the continuous trading sessions, so an intraday comparison of the data of interest is allowed.
[13] Nasdaq GlobeNewswire is the leading provider of dissemination services in the Nordic area and disseminates all types of company news.

announcements that are released out of continuous trading sessions or during the first and last hour of the trading sessions.

Following this rule, I collect 120 earnings announcement events of 15 large-cap stocks on Nasdaq Helsinki over the period between April 2014 and December 2017. After excluding the events of which the stock was traded less than 10 times during any hour of the trading sessions on its announcement day, the sample is left with 115 earnings announcements of 14 stocks. Table A.1 in the appendix reports the firm names, news headlines, and publication timestamps of all 115 sample events.

4.3 Unsophisticated Traders' Unwillingness to Trade

4.3.1 Identification of Unsophisticated Traders

The end-of-the-day transaction records provided by Nasdaq Helsinki contain the identifiers of the participating brokers of all trades, but the identities of the real investors are unobservable. Nevertheless, Linnainmaa and Saar (2012) show that the identity of the representing broker predicts the real investor type. This is because different brokers typically have distinct clientele: some brokers mainly cater to institutional investors and/or high-end individuals, who are generally sophisticated and informed, whereas other brokers mainly serve retail investors, who are usually unsophisticated and uninformed.

Following Meling (2018), I categorize orders from brokers that provide online discount brokerages as unsophisticated and the residual orders as sophisticated. Among the 92 brokers who are or were active on Nasdaq Helsinki, 30 are categorized as discount brokers who have retail investors as one of their major client groups.[14] The rest of the brokers all state explicitly or implicitly on their websites that they only cater to institutional investors and/or high-end individuals, offer

[14] The discount brokers include ABN AMRO Clearing Bank, Arbejdernes Landsabnk, Avanza Bank, Danske Andelskassers Bank, Danske Bank, DeGiro, Den Jyske Sparekasse Bank, DiBa Bank, Djurslands Bank, DnB Bank, Jyske Bank, Møns Bank, Nordea Bank, Nordfyns Bank, Nordnet Bank, OP Corporate Bank, Pareto Securities, RBC Europe, SkandiaBanken, Skandinaviska Enskilda Banken, Skjern Bank, Sparekassen Sjælland Bank, Swedbank, Svenska Handelsbanken, Sydbank, Totalbanken, UBS, UB Securities, Vestjysk Bank, and Ålandsbanken. Some of these brokers have proprietary trading desks or offer investment portfolios and asset management services to their clients, but this measurement error should not alter the empirical results given that it is random and affects only the dependent variable.

professional asset management services, or serve as market makers. Based on this categorization, I define a trade to be sophisticated if either party of the trade is a non-discount broker. Following this rule, 92.3% of trades on the sample announcement days are sophisticated, as shown in Table 1. Table 1 also shows that sophisticated trades represent a greater proportion of trades before than after announcements on the sample announcement days. This finding is inconsistent with Kim and Verrecchia's (1994) prediction about more informed trading after earnings announcements.

Table 2 presents the fractions of anonymous and non-anonymous trades among sophisticated and unsophisticated trades. On announcement days, 97.6% of sophisticated trades are anonymous, and this fraction is slightly larger before than after announcements and the difference is statistically significant at the 1% level. This implies that 1) most non-discount brokers choose to trade anonymously; and 2) non-discount brokers who are anonymous are more preferred by sophisticated traders before than after announcements. Meanwhile, only 17.2% of unsophisticated trades are anonymous, suggesting that only a few discount brokers choose to trade anonymously. In contrast to the variation of the fraction of anonymous trades among sophisticated trades, the fraction of anonymous trades among unsophisticated trades is smaller before than after announcements, implying that discount brokers who are non-anonymous are more preferred by unsophisticated traders before than after announcements.

[INSERT TABLE 2]

4.3.2 Measurement of Unsophisticated Traders' Unwillingness to Trade

Knowing who the unsophisticated investors are enables the identification of the liquidity provided by them. In this paper, I measure unsophisticated traders' unwillingness to trade by the time elapsed from trades to the following unsophisticated order, which is referred to as duration-until-next-unsophisticated-order, or *DUNUO* for short.[15] The reciprocal of *DUNUO* can be interpreted as

[15] The following unsophisticated order can be either a limit or a market order.

a proxy for the unsophisticated traders' speed of trading, and a longer *DUNUO* (and thus lower speed of trading) implies a greater unwillingness of unsophisticated investors to provide liquidity.

Although it is unprecedented to use the duration between trades and unsophisticated orders to proxy unsophisticated liquidity, the idea of using duration-between-trades as a measure of trading activity is not novel. Diamond and Verrecchia (1987) and Easley and O'Hara (1992) argue that a "no-trade" observation, or duration-between-trades, conveys information to market makers and uninformed traders, and therefore affects security prices and bid-ask spreads.[16] Based on these theoretical models, later studies empirically investigate the effect of duration-between-trades in security price process by using it as an explanatory variable (e.g., Dufour and Engle, 2000; Hausman, Lo, and MacKinlay, 1992) or incorporating it when designing new model frameworks (e.g., Engel, 2000; Engle and Russell, 1998; Manganelli, 2005). In addition to the findings about duration-between-trades affecting future prices and spreads, Dufour and Engle (2000) show that past returns and volume affect future time between trades as well, suggesting that investors dynamically adjust their trading activities in response to previous trades. In this paper, I assume that *DUNUO* partially depends on whether the preceding trade is anonymous or non-anonymous.

As its name suggests, *DUNUO* measures the time difference between a trade, which I call the *leader*, and its following unsophisticated order, which I call the *follower*. I compute *DUNUO* for each displayable trade recorded in ITCH data except for certain trades with complications.

In the computation of *DUNUO*, two complications could arise for which special treatments are needed. The first is that multiple trades can occur at exactly the same time, as shown in Panel A of Figure 2. For such cases, I group *leaders* executed at the same time together and define the *leader* group to be anonymous as long as one of the *leaders* is anonymous. The group of *leaders* is then seen

[16] Diamond and Verrecchia's (1987) model assumes a periodic occurrence of news (either good or bad) and argues that with the presence of short-selling prohibitions, the lack of trades implies the existence of bad news and thus widens the bid-ask spread. By allowing for the possibility of "no-news," Easley and O'Hara (1992) consider "no-trade" a signal of no-news, which leads to a narrower spread.

as a time-unique trade. The second problem is that a *leader* is not usually directly followed by a *follower*. When there are one or more trades (which are also *leaders*) between a *leader* and its *follower*, if the *leader* and the trade(s) in between are both (all) anonymous or both (all) non-anonymous, *DUNUO* is clearly defined and measured as the difference between the timestamps of the *leader* and *follower*, ignoring the trade(s) in between. However, if the *leader* and the trade(s) in between are of different types, the impact of the *leader* on its *follower* is contaminated by these trade(s), so this sort of *leaders* is excluded from the sample, as shown in Panel B of Figure 2.

[INSERT FIGURE 2]

Panel A of Table 3 reports the summary statistics of *DUNUO* with anonymous and non-anonymous *leaders* around earnings announcements. As expected, *DUNUO* is shorter when the *leader* is non-anonymous or occurs after earnings announcements in terms of both mean and median.[17] More importantly, the statistically significant difference-in-difference estimator presented in Panel C indicates that the disclosure of earnings information reduces the difference between the average *DUNUO* with anonymous *leaders* and the average *DUNUO* with non-anonymous *leaders* by 13.5 seconds, representing about 60.4% of the *DUNUO* difference before announcements. This result implies a statistically and economically significant reduction of the negative impact of anonymity on unsophisticated liquidity that is caused by information disclosure.

[INSERT TABLE 3]

4.3.3 *DUNUO* and Other Measures of Unsophisticated Liquidity

How well *DUNUO* captures unsophisticated liquidity depends on whether unsophisticated traders observe the latest trade and make decisions based on the information contained in that trade. Given the summary statistics of *DUNUO*, the decision-making process sometimes only takes a few

[17] As shown in Panel B of Table 3, the summary statistics of *DUNUO* of which the top 5% is winsorized separately for the pre- and post-announcement periods reveal the same pattern.

seconds, which is unlikely in reality. What is more likely is that unsophisticated traders can miss the latest trade because the trading platform may update trade feeds with a slight time lag, or the latest trade incidentally occurs when the trader submit her order. To address this issue, I take more unsophisticated orders following a trade into consideration and compute the average of the durations between a trade and the following 5 unsophisticated orders, which I call the *ADUNUO-5*, and the average of the durations between a trade and the following 10 unsophisticated orders, which I call the *ADUNUO-10*. Table 4 reports the means and standard deviations of *DUNUO*, *ADUNUO-5*, and *ADUNUO-10* after anonymous/non-anonymous trades before/after earnings announcements.

[INSERT TABLE 4]

As shown in Table 4, the average durations that concern more following unsophisticated orders are clearly longer than *DUNUO*: on announcement days, the mean of *ADUNUO-5* ranges from 19.0 seconds to 107.4 seconds and the mean of *ADUNUO-10* ranges from 34.9 seconds to 185.4 seconds. However, both average durations follow the same pattern as *DUNUO*: both *ADUNUO-5* and *ADUNUO-10* are shortest following a non-anonymous trade after announcements and longest following an anonymous trade before announcements.

In addition, I compare *DUNUO* with two other types of unsophisticated liquidity measures: volume of the following unsophisticated order and the following fraction of unsophisticated orders. The volume of the following unsophisticated order is the size of the unsophisticated order following a *leader*. As shown in Table 4, the unsophisticated volume is relatively smaller if the *leader* is anonymous, both before and after announcements. However, there is no clear pattern in the volume of unsophisticated orders over the course of announcement days.

The following fraction of unsophisticated orders is measured as the proportion of unsophisticated orders following a *leader* over a defined length of time. In Table 4, I report the descriptive statistics of the following fraction of unsophisticated orders over a 1-minute, 2-minute, and 5-minute horizon. A greater value of the following fraction of unsophisticated orders indicates a greater willingness to

trade of unsophisticated traders, and a smaller fraction implies that unsophisticated traders are less willing to trade. For the three different time lengths, the fraction of unsophisticated orders is greater following a non-anonymous trade or after announcements and smaller following an anonymous trade or before announcements. This pattern resembles that of *DUNUO*, confirming that *DUNUO* is a valid measure for unsophisticated liquidity.

4.3.4 *DUNUO* and Conventional Liquidity Measures

Whereas conventional liquidity measures such as spread and price impact assess market liquidity in general, *DUNUO* aims at capturing the liquidity provided by unsophisticated traders. Table 5 presents the means and standard deviations of *DUNUO*, 5-minute forward spread change, and 5-minute forward price impact conditional on the dummy variables *Disclosure* and *Anonymity*.

[INSERT TABLE 5]

The 5-minute forward spread change is the absolute change of the relative quoted spread over a 5-minute horizon from the time of a trade. As Table 5 shows, the average 5-minute forward spread change is 2.33 basis point before earnings announcements and close to 0 after announcements, implying that trades deteriorate market liquidity before announcements but have little impact on liquidity after announcements. This is in line with the finding that *DUNUO* is reduced by information disclosure. On the other hand, although *DUNUO* with non-anonymous *leaders* is less than half of *DUNUO* with anonymous *leaders* on average, there is no clear evidence that anonymous trades and non-anonymous trades have a significantly different impact on the overall market liquidity in terms of forward spread change.

The 5-minute forward price impact is calculated as the relative percentage change in stock midpoint quote over a 5-minute horizon following a trade execution. Unlike *DUNUO* and the 5-minute forward spread change, the average 5-minute forward price impact does not capture any effect of information disclosure nor trader anonymity on market liquidity.

The results in Table 5 suggest that liquidity is multifaceted—the conventional measures hardly capture the liquidity provided by unsophisticated traders. A specifically designed measure like *DUNUO* is more suitable for studying unsophisticated liquidity.

4.4 Trading Costs as Control Variables

Controlling for trading costs in analyses is important in this paper because they may be correlated with both the explanatory and explained variables. As one of the explanatory variables of interest, information disclosure may lead to a change in trading costs, whereas as the explained variable, unsophisticated liquidity may be affected by prevailing trading costs. Therefore, the effect of information disclosure on *DUNUO* may take place partially via trading costs in the way that past overall liquidity affects unsophisticated liquidity in the near future. In this paper, I use lagged trading cost measures such as spread, market depth, and price volatility as control variables. The trading costs measures are computed for each of the sample trades.

4.4.1 Measures of Trading Costs

Calculating the contemporaneous spread, market depth, and price volatility right after a trade requires the knowledge of the order book at the time of trade execution, so the first step of obtaining the control variables is to build the real-time order book whenever a sample trade occurs. The control variables are defined as follows.

Spread Effective spread is a common measure of trading costs (e.g., Bessembinder and Kaufman, 1997a, 1997b; Huang and Stoll, 1996; Lee, 1993). In this paper, the relative effective spread for a following unsophisticated order is defined as:

$$Relative\ Effective\ Spread = 200 \times Dir \times (P_{order} - P_{mid}) \,/\, P_{mid}$$

where *Dir* and P_{order} are the direction and price of the following unsophisticated order and P_{mid} is the midpoint of the best ask and bid prices after the leading trade is executed. *Dir* is 1 for buys and -1 for sells. The relative effective spread for the following unsophisticated order shows the potential

trading cost faced by the unsophisticated traders, and it may also reveal their reactions to the prevailing trading costs.

Market Depth Following Peterson and Sirri's (2002) idea, I use quote imbalance to measure market depth, which is defined as:

$$Quote\ Imbalance = 2 \times Dir \times (S_{ask} - S_{bid}) / (S_{bid} + S_{ask})$$

where *Dir*, the direction of the following unsophisticated order, is 1 for buys and -1 for sells, and S_{bid} and S_{ask} are the size of the best bid and best ask after the leading trade is executed.

Price Volatility Price volatility is defined as the quote midpoint volatility during the 15 minutes preceding the trade (including the trade itself). The calculation of past volatility requires an evenly spaced record of historical order books. Knowing the timestamp of a trade, I build historical order books over the 15-minute horizon preceding the trade at a 5-second frequency. Then I multiply the standard deviation of the 180 evenly spaced high frequency quote midpoints by the square root of 12 to obtain the 1-minute price volatility.

4.4.2 Trading Costs and *DUNUO* Around Earnings Announcements

In market microstructure literature, adverse selection cost is one of the determinants of trading costs (e.g., Glosten and Harris, 1988; Glosten and Milgrom, 1985; Stoll, 1989). Eleswarapu, Thompson, and Venkataraman (2004) find that after the SEC passed Regulation Fair Disclosure (FD), which reduced the degree of information asymmetries in the stock market, the adverse selection component of trading costs declined. Nevertheless, trading costs also involve aspects such as quote imbalance and price volatility, so the positive relationship between information asymmetry and trading cost may not always hold.

Consistent with Lee, Mucklow, and Ready's (1993) finding, Panel A of Table 6 shows that the post-announcement period is accompanied by widening spreads and falling depths. Additionally, Panel A shows that price volatility increases after announcements. Lee, Mucklow, and Ready (1993)

relate the decreased liquidity after announcements to greater trading volume, and this is in line with my finding about surging trading activity as shown in Table 1. One explanation for the greater trading costs and lower liquidity after announcements is that after earnings information is disclosed, more traders, both sophisticated and unsophisticated, are more willing to trade in the market, draining the existing liquidity and driving up the component of trading cost that is related to the demand of immediacy (typically known as the inventory risk cost component).

[INSERT TABLE 6]

Panel B of Table 6 reports the Pearson correlations between *DUNUO* and the lagged trading cost measures conditional on whether the earnings announcement has been made and whether the *follower* is a limit or market order. The results reveal a few interesting phenomena. First, *DUNUO* tends to be negatively correlated with the relative effective spread when the *follower* is a limit order and positively correlated with it when the *follower* is a market order. The correlations between *DUNUO* and the relative effective spread suggest that unsophisticated traders may submit orders strategically: when unsophisticated traders plan to submit limit orders, to ensure time priority, they act faster when the prevailing trading cost is greater; on the other hand, when their plan is to submit market orders, unsophisticated traders are less willing to act when the prevailing trading cost is high.

Second, quote imbalance is negatively correlated with *DUNUO*, indicating that unsophisticated traders are more willing to trade when market is deeper. Third, the correlation between price volatility and *DUNUO* is positive before announcements when unsophisticated trades submit limit orders, and negative otherwise. This suggests that unsophisticated liquidity providers are less willing to trade when the market is volatile and private information is likely to exist. These findings are consistent with expectations and provide more evidence for Chordia, Roll, and Subrahmanyam's (2000) findings on co-movements in liquidity measures.

5 Methodology and Main Results

5.1 Impact of Anonymity on Unsophisticated Liquidity

The summary statistics shown in Panel A of Table 3 suggest that unsophisticated liquidity, measured by *DUNUO*, is lower after anonymous trades than after non-anonymous trades, implying that anonymity has a negative impact on unsophisticated liquidity. However, the interpretation of the finding that *DUNUO* is longer after anonymous trades may be problematic if most anonymous trades are sophisticated: unsophisticated traders may simply prefer not to trade after sophisticated trades, regardless of whether they possess private information. The fact that about 98.5% of anonymous trades are sophisticated on the sample announcement days raises this concern.

To disentangle the effect of anonymity resulting from informational advantage from that caused by sophisticated traders' identity per se, I conduct an OLS regression of *DUNUO* on an anonymity dummy and an observable trader type dummy. The regression model is shown as follows:

$$DUNUO_{it} = \alpha + \beta_1 A_{it} + \beta_2 TS_{it} + \varepsilon_{it} \quad (1)$$

where $DUNUO_{it}$ is the duration-until-next-unsophisticated-order for trade *t* (*leader*) of announcement event *i*; A_{it} is the anonymity dummy indicating whether trade *t* of event *i* is anonymous or non-anonymous; and TS_{it} is the observable trader type dummy that indicates whether trade *t* of event *i* is non-anonymous and sophisticated or not. Since the following unsophisticated order of trade *t* occurs after trade *t*, the independent variables are essentially lagged variables.

Column (1) of Table 7 presents the estimation result of a linear regression and column (2) reports the estimation result of the regression that controls for the firm and date fixed effects and in which the standard errors are clustered at the firm level. Using the result in column (2) as an example, *DUNUO* after non-anonymous and unsophisticated trades is 10.3 seconds shorter than that after anonymous trades, but not significantly different from that after non-anonymous and sophisticated

trades. This result suggests that the preceding trade being sophisticated per se does not deter unsophisticated traders from trading. It is trader anonymity that affects unsophisticated liquidity.

[INSERT TABLE 7]

5.2 Information Asymmetry and A Dynamic Impact of Anonymity

To test whether a lower level of information asymmetries is associated with a lower negative impact of anonymity on unsophisticated liquidity, I conduct OLS regressions of *DUNUO* on an anonymity dummy, an information disclosure dummy, their interaction, and control variables. The regression model is as follows:

$$DUNUO_{it} = \alpha + \beta_1 A_{it} + \beta_2 D_{it} + \beta_3 (A_{it} D_{it}) + \sum_{k=1}^{K} \gamma_k X_{itk} + \varepsilon_{it} \quad (2)$$

where D_{it} is the information disclosure dummy that indicates whether trade *t* of event *i* is executed during the pre-announcement or post-announcement period; and X_{itk} represents the lagged *k*th control variable for trade *t* of event *i*, which is one of the selected trading cost measures including the relative effective spread, quote imbalance, and 1-minute price volatility during the past 15 minutes.

Table 8 reports the estimation results of a variety of regressions based on regression model (2). In column (1), I estimate regression model (2) without control variables and find that trader anonymity has a statistically significant positive effect on *DUNUO*, implying a negative impact of trader anonymity on unsophisticated traders' willingness to trade. In addition, I find that information disclosure has a statistically significant negative effect on *DUNUO*, indicating a positive impact of information disclosure on unsophisticated liquidity. Moreover, the result shows that *DUNUO* with anonymous *leaders* declines more after announcements than that with non-anonymous *leaders*, suggesting that the negative impact of anonymity on unsophisticated liquidity diminishes with information disclosure. I control for the firm and date fixed effects and the standard errors are clustered at the firm level, so these findings are not subject to firm- or date-specific effects.

[INSERT TABLE 8]

Using the average *DUNUO* with non-anonymous *leaders* before announcements (18.8 seconds) as a benchmark, column (1) of Table 8 shows that before announcements, trader anonymity increases *DUNUO* by 21.0 seconds, which is about 1.12 times the benchmark *DUNUO*; information disclosure reduces *DUNUO* with non-anonymous *leaders* by 12.5 seconds, which represents about 67% of the benchmark *DUNUO*; and, after announcements, *DUNUO* with anonymous *leaders* declines by an extra 12.7 seconds compared with *DUNUO* with non-anonymous *leaders*, implying that information disclosure reduces the difference between the average *DUNUO* with anonymous *leaders* and the average *DUNUO* with non-anonymous *leaders* by 61%. These results are both statistically and economically significant. The same regressions with the logarithm of one plus *DUNUO* as the dependent variable have been conducted and the findings still hold.[18]

In columns (2) to (4), I control for different measures of trading costs to see whether lagged trading cost drives away the impact of anonymity and information disclosure on *DUNUO*. Columns (2) reports the regression result when the relative effective spread is controlled for. The result shows that there is no significant relationship between *DUNUO* and the lagged relative effective spread. Columns (3) reports that the lagged quote imbalance has a negative impact on *DUNUO*. Column (4) shows that greater lagged price volatility leads to a shorter *DUNUO*. In all these tests, the direction and magnitude of the explanatory variables are not affected by the addition of the control variable, and the results are still statistically significant.

Finally, I conduct a regression controlling for all three lagged trading cost measures. Result in column (5) suggests that the addition of trading cost measures to the regression model does not change

[18] Controlling for both firm and date fixed effects and clustering the standard errors at the firm level, trader anonymity increases *DUNUO* by about 68% before announcements, and information disclosure reduces *DUNUO* after non-anonymous trades by about 78%. Most importantly, the percentage increase of *DUNUO* caused by trader anonymity is reduced by 0.14 by information disclosure. All estimated coefficients are statistically significant at least at the 5% level.

my findings. These regressions are rerun using the winsorized *DUNUO* as the dependent variable, and the results are unaffected but even stronger in statistical significance.[19]

5.3 Trading Activity: A Driving Factor of DUNUO?

DUNUO is mechanically related to the prevailing trading activity in the market: during a fixed length of time, the greater the trading activity is, the shorter the average *DUNUO* should be. To show that the variation of *DUNUO* around earnings announcements is not solely driven by the changing trading acitivity caused by information disclosure, I control for the logarithm of the number of trades during the hour the *leader* occurs and its interaction with the disclosure dummy. Column (1) of Table 9 reports the results of this regression.[20]

[INSERT TABLE 9]

The result in column (1) shows that trading activity does play a role in the variation of *DUNUO* around announcements. The negative relationship between trading activity and *DUNUO* is consistent with expectation. The positive coefficient of the interaction of the trading activity measure and the disclosure dummy indicates that the negative relationship between trading activity and *DUNUO* becomes weaker in magnitude after announcements.[21] After controlling for trading activity, *DUNUO* after anonymous *leaders* is 28.0 seconds longer than that after non-anonymous *leaders* before announcements, and this difference is reduced by 23.5 seconds, or 84%, after announcements. The estimated coefficients of the anonymity dummy, disclosure dummy, and their interaction are still statistically significant at the 1% level in this test.

[19] I winsorize the top 5% of *DUNUO* data for the period before earnings announcements as well as after earnings announcements. The summary statistics of the winsorized *DUNUO* are reported in Panel B of Table 3.

[20] Some earnings announcements are not published on the hour. To accurately capture the trading activity before and after announcements, for trades right before and after these announcements, I count the number of trades from the beginning of that hour until the announcement timestamp and the number of trades from the announcement timestamp until the end of that hour, and then adjust them to hourly rates.

[21] An explanation of this result is that the impact of trading activity on *DUNUO* is not linear, as *DUNUO* is lower-bounded by zero.

In column (2), I control for the lagged relative effective spread, quote imbalance, and price volatility and the estimation result stays the same. This result suggests that the variation of *DUNUO* around earnings announcements is not fully driven by trading activity. The negative effect of trader anonymity and the positive effect of information disclosure on unsophisticated liquidity are robust to the inclusion of trading activity.

5.4 Alternative Duration Variables

As discussed in section 4.3.3, because some of the shortest *DUNUO* in sample may not reflect unsophisticated liquidity, I compute two average durations between trades and multiple following unsophisticated orders — average-duration-until-next-5-unsophisticated-orders (*ADUNUO-5*) and average-duration-until-next-10-unsophisticated-orders (*ADNUO-10*). Panel A of Table 10 reports the correlations among *DUNUO*, *ADUNUO-5*, and *ADUNUO-10*, and *DUNUO* is found to be highly correlated with the other two duration variables.

[INSERT TABLE 10]

Panel B of Table 10 presents the results of regressions in which *DUNUO* is replaced by *ADUNUO-5* and *ADUNUO-10* as the dependent variable, whereas the same explanatory variables are used. Using the results in column (2) and (4) in which trading cost measures are controlled for as examples, *ADUNUO-5* and *ADUNUO-10* after anonymous trades are approximately one minute and one and a half minutes longer than those after non-anonymous trades before announcements, indicating a statistically significant negative impact of trader anonymity on unsophisticated liquidity. Nevertheless, the discrepancy between *ADUNUO-5* after anonymous and non-anonymous trades and the discrepancy between *ADUNUO-10* after anonymous and non-anonymous trades are reduced by earnings information disclosure by 85% and 87%, respectively. The regressions results are consistent with the findings so far. Moreover, the results show that the negative impact of trader anonymity on

unsophisticated liquidity diminishes by a greater extent after announcements when more following unsophisticated orders are considered.

6 Unsophisticated Traders' Various Reactions to Anonymity

6.1 Unsophisticated Liquidity Provider and Demander

Unsophisticated traders' choice between limit orders and market orders reflect the traders' motivation of trading: providing liquidity or demanding liquidity. Trader anonymity may have different impacts on unsophisticated traders' willingness to provide and demand liquidity. Table 11 reports the results of regressions using subsamples which contain either only trades of which the *follower* is a limit order or only trades of which the *follower* is a market order.

[INSERT TABLE 11]

Column (1) and (2) of Table 11 show the impact of anonymity on unsophisticated liquidity providers without and with trading activity as a control variable. Anonymous trades are found to significantly increase *DUNUO* if the following unsophisticated trader is a liquidity provider. Similarly, column (3) and (4) report that there is a statistically significant negative impact of anonymity on unsophisticated liquidity demanders' willingness to trade, without or with trading activity as a control variable. Although unsophisticated liquidity providers and demanders are both affected by trader anonymity, the providers are more sensitive to anonymity than the demanders before announcements. As shown in column (2) and (4), before announcements, *DUNUO* after anonymous trades is 23.7 seconds longer than that after non-anonymous trades for unsophisticated liquidity demanders, whereas this difference is even larger—30.9 seconds—for unsophisticated liquidity providers. Nevertheless, this difference in *DUNUO* becomes roughly the same—4.6 seconds and 4.7 seconds—for the providers and demanders after announcements, suggesting that unsophisticated liquidity providers are more sensitive to other traders' informational advantages masked by trader anonymity than the demanders only when the information asymmetry risk is greater. The estimated coefficients of the anonymity dummy and the interaction between the anonymity and disclosure dummy in all columns are statistically significant at least at the 5% level.

6.2 Degree of Anonymity and Unsophisticated Traders' Reaction

In the previous analyses, a trade is defined as anonymous if either participant of the trade is anonymous. In this part, I categorize the sample trades into three groups according to their degree of anonymity. The three groups and their corresponding definitions are: 1) fully anonymous trades of which both trade participants are anonymous; 2) half-anonymous trades of which only one participant is anonymous; and 3) non-anonymous trades of which both participants are non-anonymous.[22] This new categorization is employed to investigate whether unsophisticated traders react differently to trades with different degrees of trader anonymity.

Panel A of Table 12 presents the means and medians of *DUNUO* of different anonymity groups around earnings announcements. Among the three groups, *DUNUO* with fully anonymous *leaders* has the highest value both before and after announcements, whereas *DUNUO* with non-anonymous *leaders* has the lowest value. *DUNUO* with half-anonymous *leaders* are placed in the middle, but there are also variations within this group conditional on whether the non-anonymous party is sophisticated or unsophisticated.

As shown by Panel A, half-anonymous *leaders* of which the anonymous party is sophisticated does not affect unsophisticated liquidity differently from half-anonymous *leaders* of which the anonymous party is unsophisticated. However, whether the non-anonymous party is sophisticated or unsophisticated makes a difference to unsophisticated traders' willingness to trade: *DUNUO* with half-anonymous *leaders* of which the non-anonymous party is unsophisticated is about half that of which the non-anonymous party is sophisticated. This finding is plausible because the type of the non-anonymous party conveys additional information to unsophisticated traders whereas full anonymity avoids such a signal.

[22] When there are multiple trades occurring at exactly the same time, the group of trades is defined as fully anonymous if at least one trade is fully anonymous, and non-anonymous if none of the trades are anonymous. If some of the trades are half-anonymous and none are fully anonymous, this group of trades is defined as half-anonymous. A group of trades with the same execution timestamp is seen as a time-unique trade.

[INSERT TABLE 12]

In Panel B of Table 12, I conduct four regressions to compare the effects of different degrees of anonymity on unsophisticated liquidity. In each of the regressions, the dependent variable is *DUNUO* and the explanatory variables include a dummy for anonymity groups, the disclosure dummy, and their interaction. I compare two of the three anonymity groups at a time. Column (1) reports the estimation result shown in column (1) of Table 8 and is served as the benchmark. Column (2) compares the effects of fully anonymous trades and non-anonymous trades on unsophisticated liquidity; column (3) compares the effects of fully anonymous trades and half-anonymous trades; and column (4) compares the effects of half-anonymous trades and non-anonymous trades.

The negative impact of the fully anonymous trades relative to the non-anonymous trades is found to be the highest: *DUNUO* with fully anonymous *leaders* is 27.9 seconds longer than *DUNUO* with non-anonymous *leaders* before announcements, but this negative impact is reduced the most, by 15.2 seconds, by information disclosure. The negative impact of the fully anonymous trades is relatively higher than that of the half-anonymous trades, as shown in column (3). *DUNUO* with fully anonymous *leaders* is 14.2 seconds longer than *DUNUO* with half-anonymous *leaders* before announcements, and their difference declines by 6.3 seconds after announcements. Although half-anonymous trades have a relatively lower negative impact on unsophisticated liquidity, their effect is still statistically and economically significant. Column (4) shows that *DUNUO* with half-anonymous *leaders* is 14.6 seconds longer than *DUNUO* with non-anonymous *leaders* before announcements, and only 5.5 seconds longer after announcements. These results suggest that unsophisticated traders react differently when they are faced with trades with different degrees of trader anonymity.

7 Robustness Tests

The results regarding the impact of trader anonymity on unsophisticated liquidity may highly rely on the way *DUNUO* is measured. In this section, I examine the effect of anonymity on an alternative measure of unsophisticated liquidity—the following fraction of unsophisticated orders and find that my findings are not subject to the use of *DUNUO* as the unsophisticated liquidity measure.

In addition, I perform two placebo tests by conducting the same regressions using intraday data on non-announcement days 1 week before or after the sample earnings announcement days and intraday data on annual-report days. The placebo tests eliminate the possibility that the effect I find about information disclosure is a pure time-of-day effect and show that a change in the level of information asymmetries indeed plays a key role.

7.1 The Following Fraction of Unsophisticated Orders: An Alternative Measure of Unsophisticated Liquidity

As discussed and shown in section 4.3.3 and Table 4, the following fraction of unsophisticated orders serves as an alternative measure of unsophisticated liquidity. In this part, I replace *DUNUO* with this measure and examine how it is affected by trader anonymity around earnings announcements. One advantage of the following fraction of unsophisticated orders is that no trade is withdrawn from the sample due to the complication depicted in Panel B of Figure 2.

Figure 3 presents the density histograms of the fractions of unsophisticated orders following anonymous/non-anonymous *leaders* both before and after announcements over a 1-minute, 2-minute, and 5-minute horizon. Using Panel A as an example, the fraction of unsophisticated orders over the 1-minute horizon after a trade is largely concentrated at the lower end of the [0, 1] interval before announcements, especially that fraction following anonymous *leaders*. After announcements, the fraction of unsophisticated orders becomes larger in general, with the fraction following anonymous

leaders still being more right-skewed. These patterns suggest that anonymity has a negative impact on unsophisticated liquidity and this impact diminishes after earnings announcements.

[INSERT FIGURE 3]

Given that a fraction is bounded between 0 and 1, the OLS regression with fixed effects is not appropriate for a test with a fractional dependent variable. Therefore, I adopt the fraction response model developed by Papke and Woodridge (1996, 2008) and use the following fraction of unsophisticated orders as the dependent variable and the anonymity dummy, disclosure dummy, and their interaction as the explanatory variables. Panels A, B, and C of Table 13 report the estimation results of regressions using the following fraction of unsophisticated orders over a 1-minute, 2-minute, and 5-minute horizon as the dependent variable, respectively. The results are essentially the same in the three panels, so I use Panel A as an example for the interpretation of the results.

[INSERT TABLE 13]

Columns (1) and (2) of Panel A report the estimation results of the fractional logit model without and with the firm fixed effect and clustered standard errors. The coefficients in these two columns indicate the direction of the marginal effects of the explanatory variables on the dependent variable: trader anonymity reduces the following fraction of unsophisticated orders to a greater extent before than after earnings announcements, whereas information disclosure increases or at least has no impact on the fraction of unsophisticated orders following non-anonymous trades. Column (3) reports the average marginal effects of the explanatory variables on the dependent variable. Trader anonymity is found to reduce the following fraction of unsophisticated orders within 1 minute by 6.0% before announcements and 2.7% after announcements.

This result is consistent with my finding using *DUNUO* as the dependent variable in an OLS regression. By comparing the average marginal effects of trader anonymity on unsophisticated liquidity across the three panels, I find that the negative effect of trader anonymity decays over time.

The longer the horizon over which the following fraction of unsophisticated orders is measured, the lower the negative effect of trader anonymity on this fraction.

7.2 Placebo Test 1: DUNUO on Non-Announcement Days

Most of the sample earnings announcements in this study were released around midday. The existing literature has widely recognized the existence of certain intraday trading patterns such as the U-shaped trading volume (e.g., Engel and Russell, 1998; Foster and Wiswanathan, 1993; Jain and Joh, 1988; Stephan and Whaley, 1990). Therefore, it is important to rule out the possibility that a midday effect is driving the intraday variation of *DUNUO* and the varying impact of anonymity on *DUNUO* on earnings announcement days. To examine whether *DUNUO* varies significantly over the course of a normal trading day, I collect intraday trade records and ITCH data of sample stocks on certain non-announcement days, which are the trading days 1 week before and after the sample announcement days. Each of the non-announcement days is split into a morning period (before the scheduled intraday call, from 10 a.m. to 2:30 p.m. EET) and an afternoon period (after the scheduled intraday call, from 2:35 p.m. to 6:25 p.m. EET).

Panel A and B of Table 14 present the descriptive statistics of *DUNUO* on the non-announcement days 1 week before and after the sample announcement days, respectively. The means and medians suggest that contrary to the findings about *DUNUO* on earnings announcement days, *DUNUO* is shorter in the morning period on non-announcement days, but the differences in *DUNUO* between the morning and afternoon periods are not significant, especially *DUNUO* with non-anonymous *leaders*. Meanwhile, the anonymity effect is robust on these days: *DUNUO* following anonymous *leaders* is consistently longer than *DUNUO* following non-anonymous *leaders*. These findings are confirmed by the regression results shown in Panel C.

[INSERT TABLE 14]

As shown in Panel C, I regress *DUNUO* on the anonymity dummy, a time of the day dummy (indicating whether the preceding trade of *DUNUO* occurs in morning or afternoon), and their interaction. The regression results suggest that trader anonymity has a significant negative impact on unsophisticated liquidity on non-announcement days, whereas unsophisticated liquidity in morning is slightly higher than or not different from in afternoon. Moreover, the non-significant coefficient of the interaction term shows that the negative impact of anonymity on unsophisticated liquidity does not vary significantly over the course of a non-announcement day.

7.3 Placebo Test 2: DUNUO on Annual-Report Days

It is possible that the variations of *DUNUO* and the negative effect of trader anonymity around earnings announcements are simply driven by the release of reports, not the stock-price relevant information contained in them. To rule out this possibility, I examine whether there are similar variations in *DUNUO* and the impact of anonymity on *DUNUO* on days when there is an announcement but no clear change in the level of information asymmetries, such as annual-report days.

In Finland, earnings announcements for the previous fiscal year are always made along with the last quarterly report of that year, so annual reports release no new information regarding companies' earnings, which has a major impact on firms' stock market performance. More importantly, Li (2008) finds that annual reports are in general very difficult to read and analyze. Therefore, it is hard even for sophisticated traders to generate private information or advanced judgments from these reports during a short period, so the level of information asymmetries is likely to stay rather stable on annual-report days.

I collect intraday trade data on 41 stock-annual-report days of 22 large-cap and main index shares on Nasdaq Helsinki between April 2014 and December 2017.[23] Details about these sample annual

[23] Like the sample earnings announcement days, the sample annual-report days are all released between 11 a.m. and 5:30 p.m. Finnish local time.

reports are reported in Table A.2 in the appendix. I conduct OLS regressions of *DUNUO* on the anonymity dummy, disclosure dummy, and their interaction with and without the trading activity measure and its interaction with the disclosure dummy as control variables. The estimation results reported in Table 15 show that the disclosure of annual reports barely has any effect on unsophisticated liquidity nor the negative impact of anonymity on unsophisticated liquidity. Meanwhile, the negative effect of trader anonymity on unsophisticated liquidity is much weaker on annual-report days.

[INSERT TABLE 15]

Overall, these results indicate that my finding about the variation of the negative impact of trader anonymity on unsophisticated liquidity cannot be purely explained by the release of reports, and a change in the level of information asymmetries is essential to this variation.

8 Conclusions

Market transparency and its relationship with market quality are of great interest to stock exchange regulators and academic researchers. Greater transparency generally means better market quality, but this claim may not be easily applicable to trader visibility. Many studies have empirically investigated the impact of trader anonymity on overall stock market liquidity, whereas the effect of trader anonymity on unsophisticated liquidity remains largely unexplored.

This paper proposes a measure of unsophisticated liquidity—duration-until-next-unsophisticated-order (*DUNUO*)—that enables the examination of the time-series impact of trader anonymity on the liquidity provided by unsophisticated investors at an intraday level. This measure is calculated as the time difference between a trade, either anonymous or non-anonymous, and the following unsophisticated order. It captures the trading speed of unsophisticated traders when they are faced with trades with different degrees of anonymity, and it essentially reveals the unsophisticated traders' unwillingness to trade.

After March 24, 2014, a voluntary post-trade anonymity model was enacted on Nasdaq Helsinki for large-cap stocks, which allows brokers to voluntarily choose on a monthly basis whether their identities are disclosed or concealed to the rest of the market in real time. Using intraday trade and order data on earnings announcement days between April 2014 and December 2017, this paper finds that unsophisticated traders are generally less willing to trade after anonymous trades. Moreover, it shows that information disclosure improves unsophisticated traders' willingness to trade, especially that after anonymous trades, implying that lowering the level of information asymmetries reduces the negative impact of anonymity on unsophisticated liquidity.

The contributions of this paper's findings are two-fold. First, it provides empirical evidence for the negative impact of trader anonymity on unsophisticated liquidity. Second, it discovers a dynamic impact of information asymmetry on the relationship between anonymity and unsophisticated

liquidity. The latter contribution, together with Foucault, Moinas, and Theissen's (2007) theoretical predictions, suggests that the mixed findings in the literature regarding the anonymity-liquidity relationship may be partially driven by the fact that the information asymmetry risks are different across the markets under investigations, which makes the impact of anonymity on overall liquidity differ across these markets.

In addition to the existing empirical literature on trader anonymity in equity markets, this paper sheds light on the trading behavior of unsophisticated investors. Unlike the traditional understanding that unsophisticated investors are intrinsically naive, this paper finds that they are aware of the risks of trading when the market is uncertain and can react strategically. A potential extension of this paper would be to further investigate unsophisticated traders' trading behavior using the newly proposed unsophisticated liquidity measure *DUNUO*.

A policy implication of the main findings of this paper is that, considering the negative impact of trader anonymity on unsophisticated liquidity and its sensitivity to changes in information asymmetry, it may not be optimal to implement an anonymity model in markets in which information asymmetry is severe. To protect the interest of unsophisticated traders, a dynamic anonymity model under which brokers can voluntarily choose to be anonymous except when information asymmetry is severe (e.g., 1 day before scheduled earnings announcements) may be employed, at the cost of price efficiency. Further studies are needed to quantify the change of social welfare under such a dynamic anonymity model.

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Table 1 Distribution of Trades and Trading Activity on Earnings Announcement Days

This table presents the proportions of anonymous/sophisticated trades on earnings announcement days, before announcements, and after announcements. The sample consists of all intraday trades of the 14 sample stocks during the continuous trading hours on the 115 sample earnings announcement days between April 2014 and December 2017. The *t*-statistic of the difference in the proportion of anonymous/sophisticated trades between the pre-announcement and post-announcement periods is reported. It also reports the number of trades in total, per announcement, and per hour.

	Entire Announcement Day	*Pre-Announcement*	*Post-Announcement*	*t-statistic |Before – After|*
Proportion of traders by type (%)				
Anonymous	91.4	93.9	90.9	4.89
Sophisticated	92.3	94.7	91.8	5.42
Number of trades	699,801	105,555	594,246	
Average number of trades				
Per announcement	6,085	918	5,167	
Per hour	723	357	905	

Table 2 Trader Anonymity among Sophisticated and Unsophisticated Trades

This table shows the fractions of anonymous and non-anonymous trades among sophisticated/unsophisticated trades on earnings announcement days, before announcements, and after announcements. The sample consists of all intraday trades of the 14 sample stocks during the continuous trading hours on the 115 sample earnings announcement days between April 2014 and December 2017. The *t*-statistics of the difference in the data of interest between the pre-announcement and post-announcement periods are calculated based on standard errors clustered at the announcement level.

	Entire Announcement Day	*Pre-Announcement*	*Post-Announcement*	*t-statistic |Before – After|*
Sophisticated trade				
% of Anonymous	97.6	98.3	97.5	3.08
% of Non-anonymous	2.4	1.7	2.5	
Unsophisticated trade				
% of Anonymous	17.2	11.6	17.8	3.01
% of Non-anonymous	82.8	88.4	82.2	

Table 3 Descriptive Statistics of *DUNUO* Conditional on Information Disclosure and Anonymity

This table presents the descriptive statistics of the unsophisticated liquidity measure duration-until-next-unsophisticated-order. The sample covers all time-unique intraday trades on the 115 sample earnings announcement days during the period from April 2014 to December 2017, which have clearly defined *DUNUO*. Panel A provides the descriptive statistics of *DUNUO* (in seconds) conditional on information disclosure and anonymity. The subscript *d* equals 0 if the *leader* of *DUNUO* occurs before announcements and 1 otherwise, and the subscript *a* is 1 when the *leader* of *DUNUO* is anonymous and 0 otherwise. Panel B shows the summary statistics of *DUNUO* of which the top 5% of data are winsorized separately for the pre-announcement and post-announcement periods. Panel C presents an estimation of the differential impact of information disclosure on *DUNUO* with anonymous *leaders* and *DUNUO* with non-anonymous *leaders*. The *t*-statistic of the difference-in-difference estimator is calculated based on standard errors clustered at the announcement level.

Panel A: Descriptive statistics of duration-until-next-unsophisticated-order (in seconds)

$DUNUO_{da}$	*Mean*	*Std. Dev*	*Median*	*Max*	*No. of Obs*
$DUNUO_{01}$	41.08	96.28	12.46	1777.34	61,020
$DUNUO_{00}$	18.75	37.35	4.57	441.29	1,579
$DUNUO_{11}$	14.56	54.70	2.48	3649.09	313,635
$DUNUO_{10}$	5.71	17.52	0.69	608.75	12,234

Panel B: Descriptive statistics of winsorized *DUNUO* (in seconds)

$DUNUO_{da}$	*Mean*	*Std. Dev*	*Median*	*Max*	*No. of Obs*
$DUNUO_{01}$	32.95	48.65	12.46	194.14	61,020
$DUNUO_{00}$	18.09	32.79	4.57	194.14	1,579
$DUNUO_{11}$	10.39	18.11	2.48	73.82	313,635
$DUNUO_{10}$	5.12	11.97	0.69	73.82	12,234

Panel C: Impact of information disclosure on *DUNUO* with anonymous and non-anonymous *leaders*

Estimation	*Difference*	*t-statistic*
$(DUNUO_{01} - DUNUO_{00}) - (DUNUO_{11} - DUNUO_{10})$	13.48	4.19

Table 4 *DUNUO* and Other Measures of Unsophisticated Liquidity

This table presents the means and standard deviations (in parentheses) of seven measures of unsophisticated liquidity: duration-until-next-unsophisticated-order (*DUNUO*, in seconds), average-duration-until-next-5-unsophisticated-orders (*ADUNUO-5*, in seconds), average-duration-until-next-10-unsophisticated-orders (*ADUNUO-10*, in seconds), trade volume (number of shares) of the next unsophisticated order, and fractions of unsophisticated orders during the 1-, 2-, and 5-minute horizons following a trade, conditional on information disclosure and anonymity. The sample covers all time-unique intraday trades on the 115 sample earnings announcement days during the period from April 2014 to December 2017, which have clearly defined *DUNUO*.

	Pre-Announ. & Anonymous	*Pre-Announ. & Non-anonymous*	*Post-Announ. & Anonymous*	*Post-Announ. & Non-anonymous*
DUNUO	41.08 (96.28)	18.75 (37.35)	14.56 (54.70)	5.71 (17.52)
ADUNUO-5	107.40 (179.67)	65.69 (89.27)	38.36 (98.85)	19.01 (43.72)
ADUNUO-10	185.36 (281.89)	118.33 (136.22)	66.20 (151.19)	34.93 (72.04)
Unsophisticated Volume	420.09 (841.17)	437.14 (949.97)	400.24 (998.60)	449.49 (1052.20)
% of unsophisticated orders (1-min)	5.31 (6.91)	11.68 (14.50)	9.24 (7.33)	13.25 (9.36)
% of unsophisticated orders (2-min)	5.49 (6.12)	11.41 (12.85)	9.29 (6.48)	12.89 (8.05)
% of unsophisticated orders (5-min)	5.51 (5.20)	10.91 (11.76)	9.28 (5.70)	12.34 (6.78)

Table 5 Mean Comparison Tests of *DUNUO* and Conventional Liquidity Measures

This table compares the unsophisticated liquidity measure duration-until-next-unsophisticated-order (*DUNUO*, in seconds) with two post-trade liquidity measures: the absolute change of the relative effective spread (Δ*RES*, in basis point) and the permanent price impact (*PPI*, in basis point) over a 5-minute horizon. It presents the means and standard deviations (in parentheses) of the measures before and after earnings announcements and following anonymous *leaders* and non-anonymous *leaders*. It also reports the mean differences in the measures between the pre-announcement and post-announcement periods, and between the anonymous and non-anonymous groups. The sample covers all time-unique intraday trades on the 115 sample earnings announcement days during the period from April 2014 to December 2017, which have clearly defined *DUNUO*. The notations ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively, which represent the *t*-statistics calculated based on standard errors clustered at the announcement level.

	Pre-Announcement	*Post-Announcement*	Difference	*Anonymous*	*Non-Anonymous*	Difference
DUNUO	40.51	14.23	-26.29***	18.88	7.20	-11.67***
	(95.30)	(53.80)		(64.12)	(21.18)	
Δ*RES*	2.33	0.34	-2.00***	0.67	0.47	-0.19
	(11.42)	(13.67)		(13.22)	(16.58)	
PPI	6.39	7.17	0.78	6.95	9.69	2.75
	(58.07)	(74.53)		(71.49)	(87.79)	

Table 6 Trading Costs, Information Disclosure, and *DUNUO*

This table presents the descriptive statistics of three trading cost measures and the correlations between the post-trade *DUNUO* and these peri-trade trading cost measures. The trading cost measures include the relative effective spread (*RES*), quote imbalance (*IMB*), and 1-minute price volatility during the past 15 minutes (*VOL*). Panel A presents the means and standard deviations (in parentheses) of these measures around earnings announcements and the mean differences. Panel B reports the Pearson correlations among *DUNUO* and the trading cost measures conditional on whether earnings announcements have taken place and the type of the *follower*. The sample covers all time-unique intraday trades on the 115 sample earnings announcement days during the period from April 2014 to December 2017, which have clearly defined *DUNUO*. The notations ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Panel A: Summary statistics and mean comparison of trading cost measures

	Pre-Announcement	*Post-Announcement*	Difference
RES	0.00 (2.37)	0.14 (5.89)	0.14
IMB	0.03 (1.04)	0.02 (1.07)	-0.01
VOL	0.13 (0.12)	0.32 (0.48)	0.20***

Panel B: Conditional correlations between *DUNUO* and trading cost measures

	DUNUO	*RES*	*IMB*	*VOL*
	Disclosure = 0; *Follower*: Market order			
DUNUO	1			
RES	0.02***	1		
IMB	-0.01	-0.02***	1	
VOL	-0.03***	0.02***	-0.00	1
	Disclosure = 0; *Follower*: Limit order			
DUNUO	1			
RES	-0.04***	1		
IMB	-0.01	0.01	1	
VOL	0.01**	0.03***	-0.01	1
	Disclosure = 1; *Follower*: Market order			
DUNUO	1			
RES	0.02***	1		
IMB	0.00	-0.03***	1	
VOL	-0.08***	-0.01***	0.01*	1
	Disclosure = 1; *Follower*: Limit order			
DUNUO	1			
RES	-0.01***	1		
IMB	-0.01***	-0.01*	1	
VOL	-0.10***	-0.07***	-0.01***	1

Table 7 OLS Regressions of *DUNUO* on Anonymity Dummy and Observable Trader Type Dummy

This table shows the results of the OLS regressions of duration-until-next-unsophisticated-order (*DUNUO*) on the anonymity dummy and observable trader type dummy. The anonymity dummy *A* is 1 when the *leader* is anonymous and 0 otherwise. The observable trader type dummy is 1 when the *leader* is non-anonymous and sophisticated and 0 otherwise. The sample covers all time-unique intraday trades on the 115 sample earnings announcement days during the period from April 2014 to December 2017, which have clearly defined *DUNUO*. Firm and date fixed effects are controlled for when indicated. *t*-statistics are computed based on standard errors clustered at the firm level when indicated and reported in parentheses. The notations ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent Variable: *DUNUO*	
	(1)	(2)
Anonymity (A)	11.62***	10.33***
	(18.60)	(5.92)
Transparent & Sophisticated (TS)	-0.22	-2.26
	(-0.17)	(-1.77)
Firm FE	NO	YES
Date FE	NO	YES
Cluster SE	NO	YES
N	388,468	388,468

Table 8 OLS Regressions of *DUNUO* on Anonymity Dummy, Disclosure Dummy, Their Interaction, and Control Variables

This table presents the results of the OLS regressions of duration-until-next-unsophisticated-order (*DUNUO*) on the anonymity dummy, disclosure dummy, their interaction, and the lagged trading costs measures as control variables. The anonymity dummy *A* is 1 when the *leader* is anonymous and 0 otherwise. The disclosure dummy *D* equals 0 if the *leader* occurs during the pre-announcement period and 1 otherwise. The control variables include the relative effective spread (*RES*), quote imbalance (*IMB*), and 1-minute price volatility during the past 15 minutes (*VOL*) prior the *leader*. The sample covers all time-unique intraday trades on the 115 sample earnings announcement days during the period from April 2014 to December 2017, which have clearly defined *DUNUO*. Firm and date fixed effects are controlled for. *t*-statistics are computed based on standard errors clustered at the firm level and reported in parentheses. The notations ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent Variable: *DUNUO*				
	(1)	(2)	(3)	(4)	(5)
Anonymity (A)	20.95***	21.10***	20.91***	19.82***	19.96***
	(3.76)	(3.73)	(3.75)	(3.60)	(3.58)
Disclosure (D)	-12.54***	-12.47***	-12.58***	-11.42***	-11.39***
	(-5.15)	(-5.22)	(-5.14)	(-4.82)	(-4.84)
A × *D*	-12.70**	-12.85**	-12.66**	-12.36**	-12.48**
	(-2.61)	(-2.61)	(-2.61)	(-2.44)	(-2.43)
RES		0.43			0.41
		(1.51)			(1.49)
IMB			-0.32**		-0.31*
			(-2.17)		(-1.83)
VOL				-9.47**	-9.38**
				(-2.27)	(-2.30)
Firm FE	YES	YES	YES	YES	YES
Date FE	YES	YES	YES	YES	YES
Cluster SE	YES	YES	YES	YES	YES
N	388,468	388,434	388,434	379,375	379,356

Table 9 OLS Regressions Controlling for Trading Activity

This table presents the results of the OLS regressions of duration-until-next-unsophisticated-order (*DUNUO*) on the anonymity dummy, disclosure dummy, their interaction, trading activity measure, its interaction with the disclosure dummy, and additional lagged control variables. The anonymity dummy *A* is 1 when the *leader* is anonymous and 0 otherwise. The disclosure dummy *D* equals 0 if the *leader* occurs during the pre-announcement period and 1 otherwise. The trading activity is measured as the logarithm of the number of trades during the hour the *leader* occurs. Additional control variables include the relative effective spread (*RES*), quote imbalance (*IMB*), and 1-minute price volatility during the past 15 minutes (*VOL*) prior the *leader*. The sample covers all time-unique intraday trades on the 115 sample earnings announcement days during the period from April 2014 to December 2017, which have clearly defined *DUNUO*. Firm and date fixed effects are controlled for and *t*-statistics are computed based on standard errors clustered at the firm level and reported in parentheses. The notations ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent Variable: *DUNUO*	
	(1)	(2)
Anonymity (A)	28.03***	27.65***
	(4.63)	(4.51)
Disclosure (D)	-106.31***	-108.58***
	(-4.34)	(-3.81)
$A \times D$	-23.53***	-22.98***
	(-4.05)	(-3.95)
$\ln(Trading\ activity)$	-34.73***	-35.81***
	(-5.74)	(-5.47)
$D \times \ln(Trading\ activity)$	18.23***	18.60***
	(4.76)	(4.08)
RES		0.36
		(1.47)
IMB		-0.36*
		(-2.07)
VOL		2.19
		(0.91)
Firm FE	YES	YES
Date FE	YES	YES
Cluster SE	YES	YES
N	388,468	379,356

Table 10 Alternative Duration Variables

This table presents the correlations between the alternative duration variables and *DUNUO* and the results of regressions with the alternative duration variables as the dependent variable. Panel A shows the Pearson correlations among duration-until-next-unsophisticated-order (*DUNUO*), average-duration-until-next-5-unsophisticated-order (*ADUNUO-5)*, and average-duration-until-next-10-unsophisticated-order (*ADUNUO-10*). Panel B reports the results of the OLS regressions of *ADUNUO*-5 and *ADUNUO*-10 on the anonymity dummy, disclosure dummy, their interaction, trading activity measure, its interaction with the disclosure dummy, and additional lagged control variables. The anonymity dummy *A* is 1 when the *leader* is anonymous and 0 otherwise. The disclosure dummy *D* equals 0 if the *leader* occurs during the pre-announcement period and 1 otherwise. The trading activity is measured as the logarithm of the number of trades during the hour the *leader* occurs. Additional control variables include the relative effective spread (*RES*), quote imbalance (*IMB*), and 1-minute price volatility during the past 15 minutes (*VOL*) prior the *leader*. The sample covers all time-unique intraday trades on the 115 sample earnings announcement days during the period from April 2014 to December 2017, which have clearly defined *ADUNUO-5* and *ADUNUO-10*. Firm and date fixed effects are controlled for and *t*-statistics are computed based on standard errors clustered at the firm level and reported in parentheses. The notations ***, **, and * indicate statistical significance at the 1%, 5%, and 10% level, respectively.

Panel A: Correlations between *DUNUO* and alternative duration variables

	DUNUO	*ADUNUO-5*	*ADUNUO-10*
DUNUO	1		
ADUNUO-5	0.82***	1	
ADUNUO-10	0.72***	0.95***	1

Panel B: OLS Regressions of alternative duration variables on anonymity dummy, disclosure dummy, their interaction, and control variables

	Dependent Variable			
	ADUNUO-5		*ADUNUO-10*	
	(1)	(2)	(3)	(4)
Anonymity (A)	55.80***	56.65***	89.91***	92.24***
	(4.36)	(4.05)	(4.12)	(3.83)
Disclosure (D)	-273.53***	-283.16***	-458.57***	-474.23***
	(-4.23)	(-3.86)	(-4.04)	(-3.73)
$A \times D$	-47.93***	-48.43***	-78.33***	-80.05***
	(-3.71)	(-3.47)	(-3.50)	(-3.27)
$\ln(Trading\ activity)$	-89.05***	-92.47***	-150.89***	-156.65***
	(-5.87)	(-5.72)	(-5.93)	(-5.82)
$D \times \ln(Trading\ activity)$	45.19***	46.79***	75.32***	77.97***
	(4.55)	(4.09)	(4.35)	(3.95)
RES		0.56		0.96
		(1.09)		(1.14)
IMB		-0.25		-0.19
		(-0.82)		(-0.44)
VOL		5.87		10.34
		(0.98)		(1.01)
Firm FE	YES	YES	YES	YES
Date FE	YES	YES	YES	YES
Cluster SE	YES	YES	YES	YES
N	387,470	378,343	386,394	377,267

Table 11 OLS Regressions Conditional on the Type of *Follower*

This table presents the results of the OLS regressions of duration-until-next-unsophisticated-order (*DUNUO*) on anonymity dummy, disclosure dummy, their interaction, trading activity measure, and its interaction with the disclosure dummy using subsamples conditional on whether the *follower* is a limit order or a market order. The anonymity dummy *A* is 1 when the *leader* is anonymous and 0 otherwise. The disclosure dummy *D* equals 0 if the *leader* occurs during the pre-announcement period and 1 otherwise. The trading activity is measured as the logarithm of the number of trades during the hour the *leader* occurs. The whole sample covers all time-unique intraday trades on the 115 sample earnings announcement days during the period from April 2014 to December 2017, which have clearly defined *DUNUO*. The sample in column (1) and (2) include only *leaders* with an unsophisticated limit order as *follower*, while the sample in column (3) and (4) contain only *leaders* with an unsophisticated market order as *follower*. Firm and date fixed effects are controlled for and *t*-statistics are computed based on standard errors clustered at the firm level and reported in parentheses. The notations ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent Variable: *DUNUO*			
	Follower: Limit order		*Follower*: Market order	
	(1)	(2)	(3)	(4)
Anonymity (A)	24.55***	30.88***	15.54***	23.66***
	(3.70)	(4.30)	(3.78)	(4.76)
Disclosure (D)	-9.90***	-114.23***	-16.23***	-94.35**
	(-4.71)	(-4.18)	(-4.64)	(-2.97)
$A \times D$	-16.37**	-26.30***	-7.16**	-18.96***
	(-2.65)	(-3.77)	(-2.31)	(-4.10)
$\ln(Trading\ activity)$		-33.19***		-36.97***
		(-6.87)		(-4.02)
$D \times \ln(Trading\ activity)$		19.24***		16.74***
		(4.57)		(3.34)
Firm FE	YES	YES	YES	YES
Date FE	YES	YES	YES	YES
Cluster SE	YES	YES	YES	YES
N	243,412	243,412	145,056	145,056

Table 12 *DUNUO* and the Degree of Anonymity

This table presents the comparisons of the unsophisticated liquidity measure duration-until-next-unsophisticated-order with *leaders* with different degrees of anonymity around earnings announcements. Panel A shows the means and standard deviations (in parentheses) of *DUNUO* with fully anonymous/half-anonymous/non-anonymous *leaders* before and after the sample announcements. For *DUNUO* with half-anonymous *leaders*, the descriptive statistics of *DUNUO* of which the anonymous/non-anonymous party of the *leader* is sophisticated/unsophisticated are also provided. Panel B reports the results of the OLS regressions of *DUNUO* on various anonymity dummy, the disclosure dummy, and their interaction. The anonymity dummy *A* is 1 when the *leader* is at least half-anonymous and 0 otherwise; $A_{F/N}$ is 1 when the *leader* is fully anonymous and 0 when it is non-anonymous; $A_{F/H}$ is 1 when the *leader* is fully anonymous and 0 when it is half-anonymous; and $A_{H/N}$ is 1 when the *leader* is half-anonymous and 0 when it is non-anonymous. The disclosure dummy *D* equals 0 if the *leader* occurs during the pre-announcement period and 1 otherwise. The sample covers all time-unique intraday trades on the 115 sample earnings announcement days during the period from April 2014 to December 2017, which have clearly defined *DUNUO*. Firm and date fixed effects are controlled for and *t*-statistics are computed based on standard errors clustered at the firm level and reported in parentheses. The notations ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Panel A: Mean/median of *DUNUO* (in seconds) with different types of *leaders*

Leader Type	*Pre-Announcement*	*Post-Announcement*
Fully anonymous	47.9 (15.8)	19.0 (4.0)
Half-anonymous	33.1 (8.7)	11.0 (1.5)
Anonymous party: Sophisticated	34.1 (9.2)	11.6 (1.6)
Anonymous party: Unsophisticated	31.4 (7.8)	10.0 (1.3)
Non-anonymous party: Sophisticated	51.4 (17.4)	18.5 (3.2)
Non-anonymous party: Unsophisticated	30.2 (7.2)	9.9 (1.3)
Non-anonymous	18.8 (4.6)	5.7 (0.7)

Panel B: Differential effects of different degrees of anonymity on *DUNUO*

	Dependent Variable: *DUNUO*			
	(1)	(2)	(3)	(4)
Anonymity (A)	20.95*** (3.76)			
Full/non-anonymity ($A_{F/N}$)		27.88*** (3.67)		
Full/half-anonymity ($A_{F/H}$)			14.22** (2.99)	
Half/non-anonymity ($A_{H/N}$)				14.61*** (3.70)
Disclosure (D)	-12.54*** (-5.15)	-12.19*** (-5.09)	-21.15*** (-4.53)	-12.10*** (-5.22)
$A \times D$	-12.70** (-2.61)			
$A_{F/N} \times D$		-15.15** (-2.38)		
$A_{F/H} \times D$			-6.31* (-1.80)	
$A_{H/N} \times D$				-9.08** (-2.72)
Firm FE	YES	YES	YES	YES
Date FE	YES	YES	YES	YES
Cluster SE	YES	YES	YES	YES
N	388,468	187,925	374,655	214,329

Table 13 Trader Anonymity and Following Fraction of Unsophisticated Orders

This table reports the estimation results of the fraction response model using the following fraction of unsophisticated orders over a 1-minute/2-minute/5-minute horizon as the dependent variable, and the anonymity dummy, disclosure dummy, and their interaction as the independent variables. The anonymity dummy *A* is 1 when the *leader* is anonymous and 0 otherwise. The disclosure dummy *D* equals 0 if the *leader* occurs during the pre-announcement period and 1 otherwise. In all panels, column (1) and (2) present the estimation results of the fractional logit model, and column (3) shows the corresponding estimated marginal average effect of the explanatory variables on *DUNUO*. The sample covers all time-unique intraday trades on the 115 sample earnings announcement days during the period from April 2014 to December 2017. Firm fixed effect is controlled for and *t*-statistics are computed based on standard errors clustered at the firm level and reported in parentheses. The notations ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Panel A: Dependent Variable – *% of unsophisticated orders (1-min)*

	Fractional Logit Model		Average Marginal Effects
	(1)	(2)	(3)
Anonymity (A)	-0.86***	-0.75***	-0.0600***
	(-30.14)	(-3.82)	(-3.82)
Disclosure (D)	0.14***	0.17	0.0136
	(5.05)	(0.82)	(0.82)
A × *D*	0.45***	0.42**	0.0333**
	(15.52)	(2.41)	(2.41)
Firm FE	NO	YES	YES
Cluster SE	NO	YES	YES
N	398,240	398,240	398,240

Panel B: Dependent Variable – *% of unsophisticated orders (2-min)*

	Fractional Logit Model		Average Marginal Effects
	(1)	(2)	(3)
Anonymity (A)	-0.80***	-0.68***	-0.0549***
	(-30.81)	(-3.56)	(-3.56)
Disclosure (D)	0.14***	0.17	0.0136
	(5.38)	(0.81)	(0.81)
A × *D*	0.43***	0.39**	0.0311**
	(16.20)	(2.32)	(2.32)
Firm FE	NO	YES	YES
Cluster SE	NO	YES	YES
N	396,579	396,579	396,579

Panel C: Dependent Variable – *% of unsophisticated orders (5-min)*

	Fractional Logit Model		Average Marginal Effects
	(1)	(2)	(3)
Anonymity (A)	-0.74***	-0.63***	-0.0504***
	(-29.76)	(-2.86)	(-2.86)
Disclosure (D)	0.14***	0.17	0.0138
	(5.58)	(0.69)	(0.69)
A × *D*	0.42***	0.38*	0.0306*
	(16.65)	(1.92)	(1.92)
Firm FE	NO	YES	YES
Cluster SE	NO	YES	YES
N	391,532	391,532	391,532

Table 14 *DUNUO* on Non-Announcement Days

Panels A and B of this table present the descriptive statistics of the unsophisticated liquidity measure duration-until-next-unsophisticated-order on non-announcement days. The sample covers all time-unique intraday trades that have clearly defined *DUNUO* on 224 non-announcement days, of which 114 days are 1 week before the sample announcement days and 110 days are 1 week after the sample announcement days. The sample period is from April 2014 to December 2017. Panel A provides the descriptive statistics of *DUNUO* (in seconds) on the non-announcement days 1 week before the announcement days, and Panel B provides the descriptive statistics of *DUNUO* (in seconds) on the non-announcement days 1 week after the announcement days. The subscript *t* equals 0 if the *leader* of *DUNUO* occurs during the morning period and 1 if it occurs during the afternoon period, and the subscript *a* is 1 when the *leader* of *DUNUO* is anonymous and 0 otherwise. Panel C presents the results of the OLS regressions of *DUNUO* on the anonymity dummy, afternoon dummy, and their interaction. The anonymity dummy *A* is 1 when the *leader* is anonymous and 0 otherwise. The afternoon dummy *T* equals 0 if the *leader* occurs during the morning period and 1 otherwise. Firm and date fixed effect is controlled for in both columns. *t*-statistics are computed based on standard errors clustered at the firm level and reported in parentheses. The notations ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

Panel A: Descriptive statistics of *DUNUO* (in seconds) on non-announcement days (1 week before)

$DUNUO_{ta-1wb}$	*Mean*	*Std. Dev*	*Median*	*Max*	*No. of Obs*
$DUNUO_{01-1wb}$	68.8	141.6	20.9	3746.5	70,150
$DUNUO_{00-1wb}$	24.3	56.0	4.7	1119.8	1,201
$DUNUO_{11-1wb}$	71.7	143.4	24.6	3412.3	66,355
$DUNUO_{10-1wb}$	23.0	47.9	4.5	533.8	795

Panel B: Descriptive statistics of *DUNUO* (in seconds) on non-announcement days (1 week after)

$DUNUO_{ta-1wa}$	*Mean*	*Std. Dev*	*Median*	*Max*	*No. of Obs*
$DUNUO_{01-1wa}$	61.7	129.2	16.1	4212.3	82,920
$DUNUO_{00-1wa}$	18.4	41.2	4.1	565.8	1,299
$DUNUO_{11-1wa}$	74.0	165.2	22.0	4012.9	75,801
$DUNUO_{10-1wa}$	20.8	37.6	6.2	360.2	828

Panel C: OLS regressions of $DUNUO_{1wb}$ / $DUNUO_{1wa}$ on anonymity dummy, afternoon dummy, and their interaction

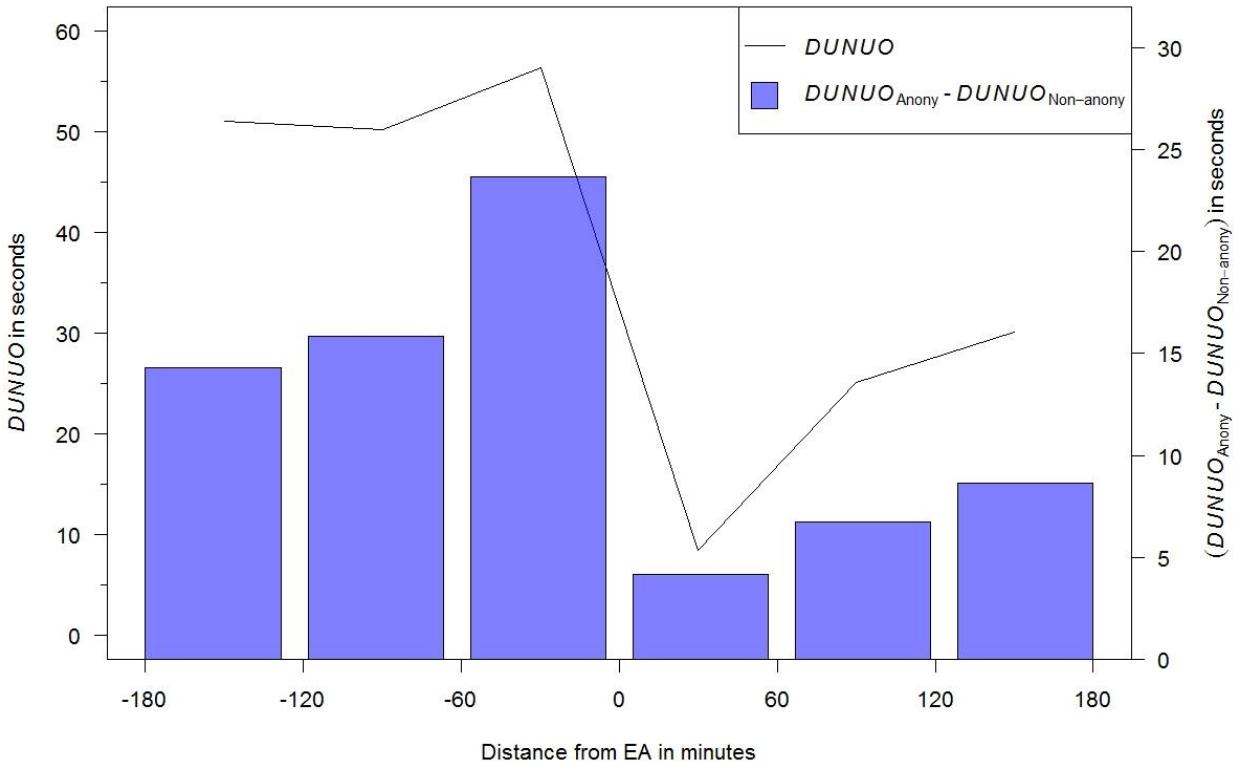
	Dependent Variable	
	(1) $DUNUO_{1wb}$	(2) $DUNUO_{1wa}$
Anonymity (A)	38.59***	20.50***
	(4.71)	(5.23)
Afternoon (T)	7.13*	1.51
	(2.09)	(0.47)
$A \times T$	-7.77	8.38
	(-1.33)	(0.97)
Firm FE	YES	YES
Date FE	YES	YES
Cluster SE	YES	YES
N	138,501	160,848

Table 15 *DUNUO* on Annual-Report Days

This table shows the results of the OLS regressions of duration-until-next-unsophisticated-order (*DUNUO*) on the anonymity dummy, disclosure dummy, and their interaction with and without trading activity and its interaction with the disclosure dummy as the control variables. The sample covers all time-unique intraday trades that have clearly defined *DUNUO* on 41 annual-report days of 22 large-cap stocks listed on Nasdaq Helsinki between April 2014 and December 2017. The anonymity dummy *A* is 1 when the *leader* is anonymous and 0 otherwise. The disclosure dummy *D* equals 0 if the *leader* occurs during the pre-announcement period and 1 otherwise. The trading activity is measured as the logarithm of the number of trades during the hour the *leader* occurs. Firm and date fixed effects are controlled for in both columns. *t*-statistics are computed based on standard errors clustered at the firm level and reported in parentheses. The notations ***, **, and * indicate significance at the 1%, 5%, and 10% level, respectively.

	Dependent Variable: *DUNUO*	
	(1)	(2)
Anonymity (A)	15.06	12.47*
	(1.51)	(1.83)
Disclosure (D)	13.25	59.32
	(1.66)	(1.24)
$A \times D$	-11.37	-1.75
	(-1.17)	(-0.30)
$\ln(Trading\ activity)$		-46.07***
		(-4.27)
$D \times \ln(Trading\ activity)$		-8.00
		(-1.06)
Firm FE	YES	YES
Date FE	YES	YES
Cluster SE	YES	YES
N	47,500	47,500

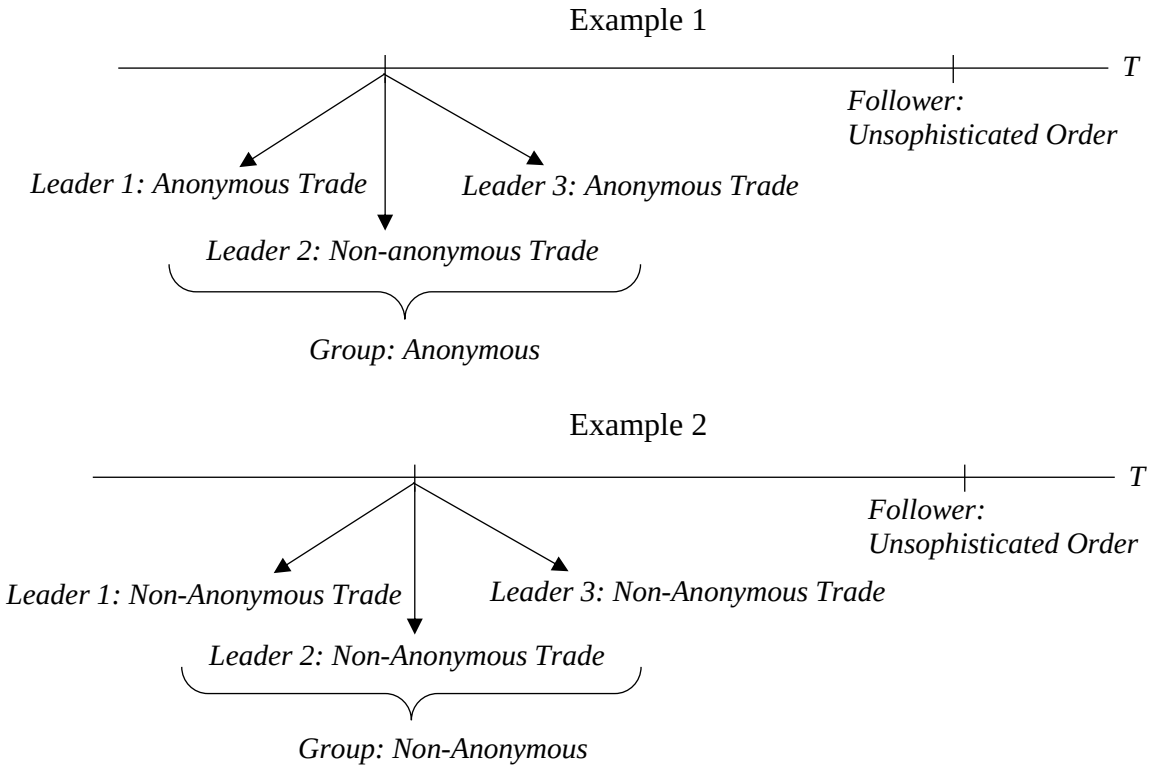
Figure 1 Equally Weighted Mean of Duration from Trade to the Following Unsophisticated Order and Equally Weighted Mean of Duration Difference Around Earnings Announcements



The solid line in this figure shows the average duration from trade to the following unsophisticated order with each of the sample announcements weighted equally. The blue bars represent the equally weighted means of the discrepancy between the duration from anonymous trades to the following unsophisticated order and duration from non-anonymous trades to the following unsophisticated order. The means are calculated for the 1-hour windows 1/2/3 hour(s) before/after the publication timestamps of the sample earnings announcements. *DUNUO* is the abbreviation for duration-until-next-unsophisticated-order. The sample covers intraday trades on 115 earnings announcement days of 14 large-cap stocks listed on Nasdaq Helsinki during the period from April 2014 to December 2017.

Figure 2 Two Complications in *DUNUO* (Duration-Until-the-Next-Unsophisticated-Order) Computation and the Solutions

Panel A: Clustered trades



Panel B: Multiple *leaders* with the same *follower*

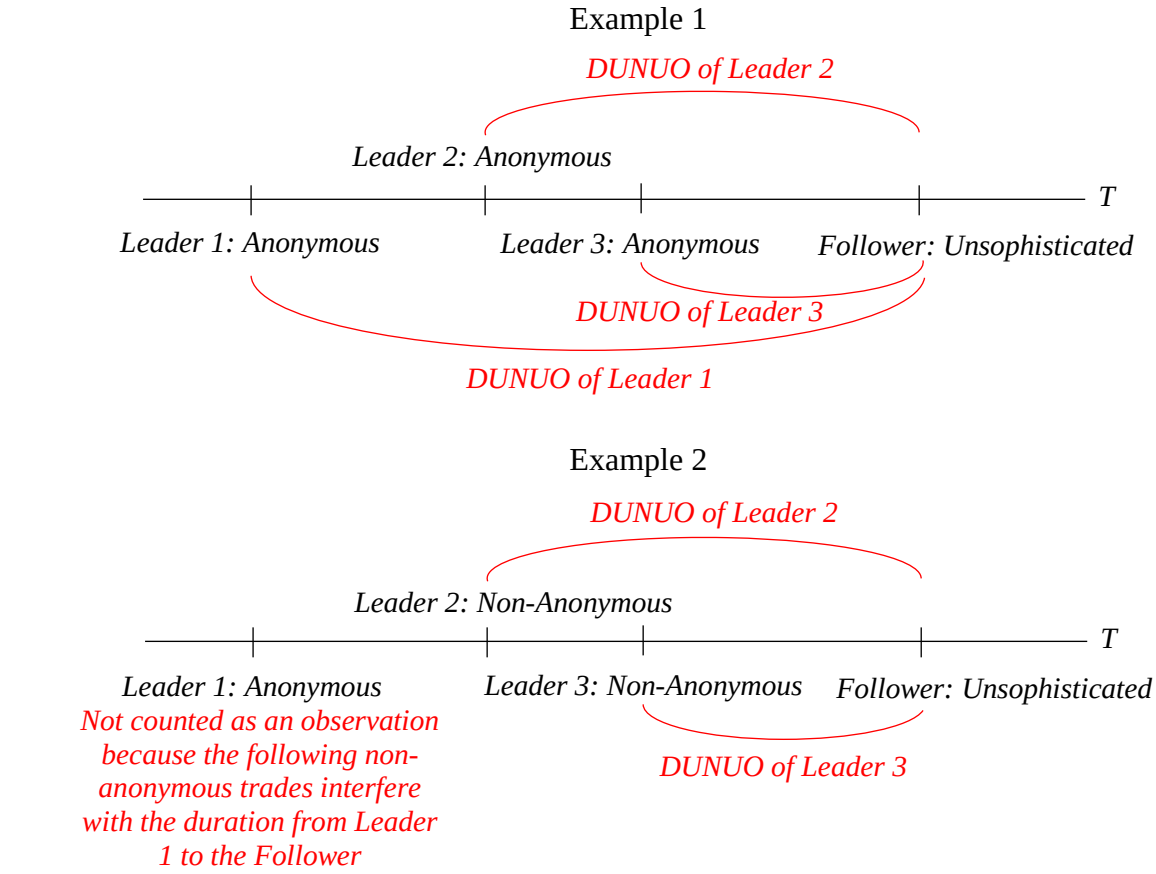
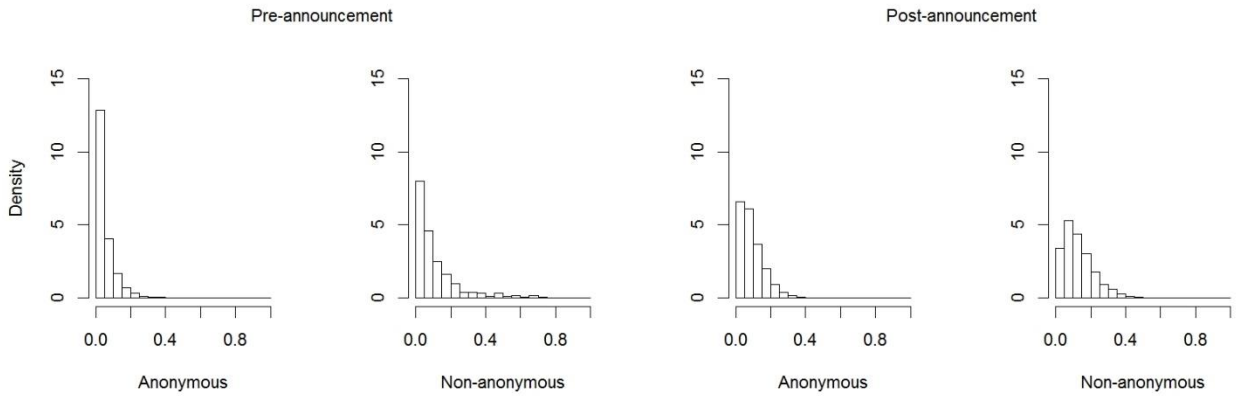
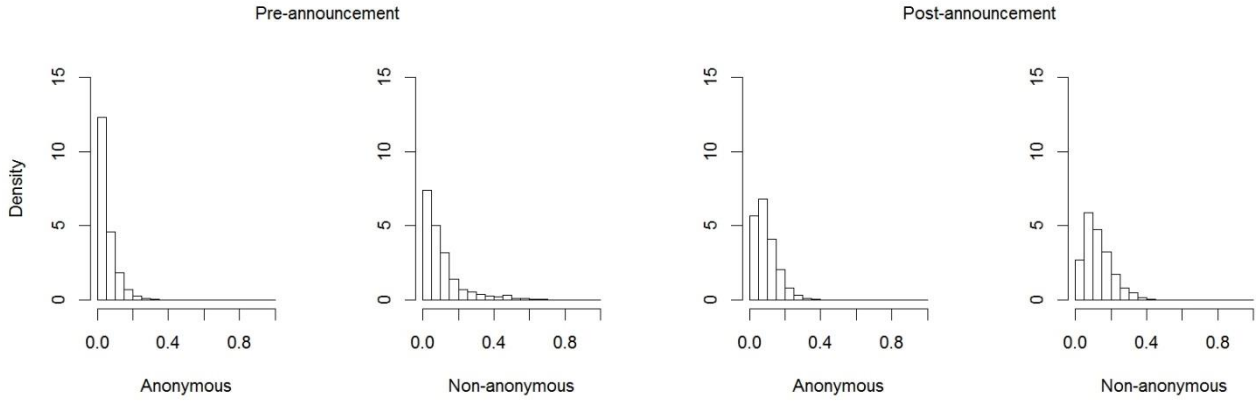


Figure 3 Histograms of Fraction of Unsophisticated Orders Following Anonymous and Non-Anonymous Trades around Earnings Announcements

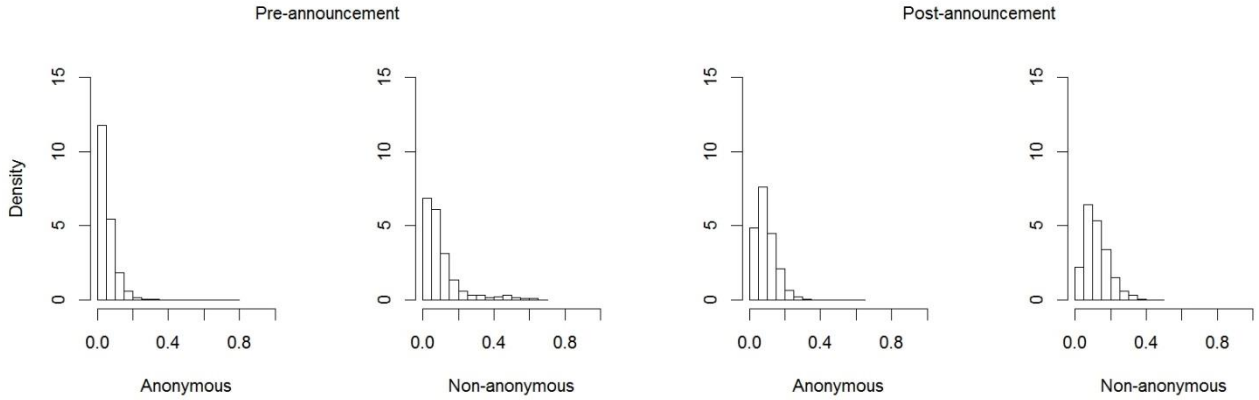
Panel A: Fraction of unsophisticated orders after a trade over a 1-min horizon



Panel B: Fraction of unsophisticated orders after a trade over a 2-min horizon



Panel C: Fraction of unsophisticated orders after a trade over a 5-min horizon



Appendix

Table A.1 Sample of Quarterly Reports of Large-Cap Companies Listed on Nasdaq Helsinki, April 2014 – December 2017 (Publication Time in EET/EEST)

Company	*News Headline*	*Publication Time*
Ahlstrom-Munksjö Oyj	Ahlstrom-Munksjö half-year report January-June 2017: Good start for the combined company with solid quarterly result	2017-07-25 13:15:00
Amer Sports	Amer Sports Corporation Interim Report January-March 2014	2014-04-24 13:10:00
	Amer Sports Corporation Interim Report January-June 2014	2014-07-24 13:00:00
	Amer Sports Corporation Interim Report January-September 2014	2014-10-23 13:00:00
	Amer Sports Corporation Financial Statements Bulletin 2014	2015-02-05 13:00:00
	Amer Sports Corporation Interim Report January-March 2015	2015-04-23 13:00:00
	Amer Sports Corporation Interim Report January-June 2015	2015-07-29 13:00:00
	Amer Sports Corporation Interim Report January-September 2015	2015-10-22 13:00:00
	Amer Sports Corporation Financial Statements Bulletin 2015	2016-02-03 13:00:00
	Amer Sports Corporation Interim Report January-March 2016	2016-04-22 11:00:00
	Amer Sports Half Year Financial Report January-June 2016	2016-07-28 13:00:00
	Amer Sports Corporation Interim Report January-September 2016	2016-10-20 13:00:00
	Amer Sports Corporation Financial Statements Bulletin 2016	2017-02-09 13:00:00
	Amer Sports Corporation Interim Report January-March 2017	2017-04-27 13:00:00
	Amer Sports Half Year Financial Report January-June 2017	2017-07-27 13:00:00
	Amer Sports Corporation Interim Report January-September 2017	2017-10-26 13:00:00
Cargotec	Cargotec's January-March 2014 interim report: operating profit improved both in Kalmar and Hiab as a result of improvement measures	2014-04-29 12:00:00
	Cargotec's January-June 2014 interim report: Orders grew but operating profit was burdened by project cost overruns in Kalmar	2014-07-18 12:00:00
	Cargotec's January-September 2014 interim report: Profit improvement progressed in Hiab and Kalmar, reorganisation launched in MacGregor	2014-10-23 12:00:00
	Cargotec's January-March 2015 interim report: improvement in all key figures	2015-04-28 12:00:00
	Cargotec's January-September 2015 interim report: Kalmar and Hiab orders and profitability developed positively, MacGregor market situation remained challenging	2015-10-21 12:00:00
	Cargotec's January-June 2016 interim report: business developed favourably	2016-07-20 12:00:00
	Cargotec's January-September 2016 interim report: operating profit margin improved	2016-10-25 12:00:00
	Cargotec's January-June 2017 half year financial report: Favourable development in profitability	2017-07-20 12:00:00

Kemira Oyj	Kemira Oyj's Interim Report January-June 2014: Revenue and operative ebit stable for continued business, revised outlook for 2014	2014-07-22 14:30:00
	Kemira Oyj's Interim Report January-March 2015: Performance continued to improve	2015-04-24 13:30:00
	Kemira Oyj's Interim Report January-June 2015: Revenue growth with improved profitability	2015-07-22 14:30:00
	Kemira Oyj's Interim Report January-June 2016: Profitability improvement continued	2016-07-21 14:30:00
	Kemira Oyj's Half-year Financial Report 2017: Solid revenue growth, profitability below prior-year level	2017-07-20 14:30:00
KONE Oyj	Interim Report of KONE Corporation for January-March 2014	2014-04-23 12:30:00
	Interim Report of KONE Corporation for January-June 2014	2014-07-18 12:30:00
	Interim Report of KONE Corporation for January-September 2014	2014-10-21 12:30:00
	Financial Statement Bulletin of KONE Corporation for January-December 2014	2015-01-29 12:30:00
	Interim Report of KONE Corporation for January-March 2015	2015-04-22 12:30:00
	Interim Report of KONE Corporation for January-June 2015	2015-07-17 12:30:00
	Interim Report of KONE Corporation for January-September 2015	2015-10-22 12:30:00
	Financial Statement Bulletin of KONE Corporation for January-December 2015	2016-01-28 12:30:00
	Interim Report of KONE Corporation for January-March 2016	2016-04-21 12:30:00
	Interim Report of KONE Corporation for January-June 2016	2016-07-19 12:30:00
	Interim Report of KONE Corporation for January-September 2016	2016-10-26 12:30:00
	Financial Statement Bulletin of KONE Corporation for January-December 2016	2017-01-26 12:30:00
	Interim Report of KONE Corporation for January-March 2017	2017-04-27 12:30:00
	KONE Corporation: Half-year Financial Report 2017	2017-07-19 12:30:00
	Interim Report of KONE Corporation for January-September 2017	2017-10-26 12:30:00
Metso Oyj	Metso's Interim Review January 1 - March 31, 2014	2014-04-24 12:00:00
	Metso's Interim Review January 1 - June 30, 2014	2014-07-31 12:00:00
	Metso's Interim Review January 1 - September 30, 2014	2014-10-23 12:00:00
	Metso's Financial Statements Review for 2014	2015-02-05 12:00:00
	Metso's Interim Review January 1 - March 31, 2015	2015-04-23 12:00:00
	Metso's Interim Review January 1 - June 30, 2015	2015-07-23 12:00:00
	Metso's Interim Review January 1 - September 30, 2015	2015-10-22 12:00:00
Metsä Board Oyj	Metsä Board Corporation’s operating result excluding non-recurring items was EUR 180 million in 2015	2016-02-03 12:00:00
	Metsä Board Corporation’s operating result excluding non-recurring items was EUR 35 million in January–March 2016	2016-05-03 12:00:00
	Metsä Board Corporation’s operating result excluding non-recurring items for January–June 2016 was EUR 70.8 million	2016-08-04 12:00:00
	Metsä Board's comparable operating result in January–September 2016 was EUR 104.7 million	2016-11-02 12:00:00
	Metsä Board's comparable operating result in 2016 was EUR 137 million	2017-02-02 12:00:00

Metsä Board Oyj	Metsä Board's comparable operating result in January–March 2017 was EUR 45 million	2017-05-04 12:00:00
	Metsä Board's comparable operating result in January–June 2017 was EUR 89 million	2017-08-03 12:00:00
	Metsä Board’s comparable operating result in January–September 2017 was EUR 139 million	2017-11-01 12:00:00
Orion	Orion Group Interim Report January-March 2014	2014-04-29 12:00:00
	Orion Group Interim Report January-June 2014	2014-07-29 12:00:00
	Orion Group Interim Report January-September 2014	2014-10-21 12:00:00
	Orion Group Financial Statement Release for 2014	2015-02-04 12:00:00
	Orion Group Interim Report January-March 2015	2015-04-29 12:00:00
	Orion Group Interim Report January-June 2015	2015-07-28 12:00:00
	Orion Group Interim Report January-September 2015	2015-10-27 12:00:00
	Orion Group Financial Statement Release for 2015	2016-02-02 12:00:00
	Orion Group Interim Report January-March 2016	2016-04-27 12:00:00
	Orion Group Half-Yearly Report January-June 2016	2016-07-19 12:00:00
	Orion Group Interim Report January-September 2016	2016-10-25 12:00:00
	Orion Group Financial Statement Release for 2016	2017-02-08 12:00:51
	Orion Group Interim Report January-March 2017	2017-04-26 12:00:00
	Orion Group Half-Year Financial Report January-June 2017	2017-07-19 13:15:52
	Orion Group Interim Report January-September 2017	2017-10-26 12:00:00
Outokumpu Oyj	Outokumpu first-quarter 2016: Underlying EBIT of EUR -20 million, operating cash flow EUR 74 million, net debt down to EUR 1,551 million	2016-04-27 12:00:00
	Outokumpu - Group underlying EBIT EUR -5 million and operating cash flow EUR 54 million - record-high deliveries and improving performance in Americas	2016-07-26 12:00:00
	Outokumpu – Solid progress continued, Group underlying EBIT clearly positive at EUR 32 million	2016-11-03 12:00:00
	Outokumpu returned to profitability in 2016: full-year underlying EBIT at EUR 45 million	2017-02-02 12:00:00
	Outokumpu - Strong start to the year, Group adjusted EBITDA at EUR 294 million	2017-04-27 12:00:00
	Outokumpu - Solid profitability despite ferrochrome production challenges, Group adjusted EBITDA at EUR 199 million	2017-07-25 12:00:00
	Outokumpu - Third-quarter earnings burdened by raw material-related losses. Group adjusted EBITDA at EUR 56 million	2017-10-26 12:00:00
Outotec Oyj	Outotec's Interim Report January-March 2015	2015-04-27 12:45:00
	Outotec's interim report January-June 2016	2016-07-27 13:00:00
	Outotec's interim report January-September 2016	2016-10-28 13:00:00
	Outotec's interim report January-March 2017	2017-05-04 13:00:00
Stockmann Oyj Abp	Publishing of Stockmann’s Interim Report for January–March 2016	2016-04-20 11:00:00

Stora Enso Oyj	Stora Enso First Quarter Results 2014	2014-04-23 13:00:00
	Stora Enso Interim Review January–June 2014	2014-07-21 13:00:00
	Stora Enso Interim Review January–September 2014	2014-10-22 13:00:00
	Stora Enso Fourth Quarter and Full Year Results 2014	2015-02-04 13:00:00
	Stora Enso Interim Review January–March 2015	2015-04-22 13:00:00
	Stora Enso Interim Review January–June 2015	2015-07-21 13:00:00
	Stora Enso Interim Review January–September 2015	2015-10-23 13:00:01
	Stora Enso Q4 and full year results 2015	2016-02-04 13:00:00
	Stora Enso Interim Report January–March 2016	2016-04-28 13:00:00
	Stora Enso Interim Report January–June 2016	2016-07-21 13:00:00
	Stora Enso Interim Report January–September 2016	2016-10-25 13:00:00
	Stora Enso Financial Statement Release 2016	2017-02-03 13:00:00
	Stora Enso interim report January–March 2017: Transformation driving sales growth	2017-04-27 13:00:00
Uponor	Uponor’s improved performance supported by North America and pick-up in Europe in the fourth quarter 2015	2016-02-12 14:00:00
	Interim report January - March 2017: Uponor’s net sales grows in all segments	2017-05-03 14:00:00
Valmet Corporation	Valmet's Interim Review January 1 - June 30, 2014: Strong development in orders received continued - profitability improvement proceeding according to plan	2014-07-31 15:00:00
	Valmet's Interim Review January 1 - September 30, 2014: Profitability continued to improve and is moving towards the targeted level	2014-10-24 12:00:00
	Valmet's Financial Statements Review January-December 2014: Profitability in the targeted range in Q4/2014 - good orders received in Services	2015-02-06 12:00:00
	Valmet's Interim Review January 1 - March 31, 2015: Orders received increased in Services - focus continues to be on profitability improvement	2015-04-29 12:00:00
	Valmet's Interim Review January 1 - June 30, 2015: Strong start for Automation as part of Valmet - profitability reached the targeted range in Q2/2015	2015-07-30 15:00:00
	Valmet's Interim Review January 1 - September 30, 2015: Strong development in orders received in China - profitability in the targeted range in Q3/2015	2015-10-28 12:00:00
	Valmet's Financial Statements Review, January 1 - December 31, 2015: Net sales increased to EUR 2.9 billion and EBITA to EUR 182 million in 2015	2016-02-09 12:00:00
	Valmet's Interim Review January 1 - March 31, 2016: Orders received, net sales and profitability increased	2016-04-27 12:00:00
	Valmet's Interim Review January 1 - June 30, 2016: Good development in Services - new way to serve customers launched	2016-07-28 14:00:00
	Valmet's Interim Review January 1 - September 30, 2016: Orders received increased and profitability improved	2016-10-27 13:00:00
	Valmet's Financial Statements Review January 1 - December 31, 2016: Orders received increased to EUR 3.1 billion and Comparable EBITA to EUR 196 million in 2016	2017-02-08 12:00:00

Valmet Corporation	Valmet's Interim Review January 1 - March 31, 2017: Orders received increased - especially in the Paper business line	2017-04-25 12:00:00
	Valmet's Half Year Financial Review January 1 - June 30, 2017: Orders received increased - profitability at the previous year's level	2017-07-27 14:19:51
	Valmet's Interim Review January 1 - September 30, 2017: Growth continued in the Paper business line - Valmet's profitability improved	2017-10-24 12:00:00

Table A.2 Sample of Annual Reports of Large-Cap Companies Listed on Nasdaq Helsinki, April 2014 – December 2017 (Publication Time in EET/EEST)

Company	*News Headline*	*Publication Time*
Amer Sports	Amer Sports Financial Review 2015 published	2016-02-15 17:00:00
	Amer Sports Financial Review 2016 published	2017-02-16 16:45:00
Cargotec	Cargotec publishes its 2016 annual report and financial statements	2017-02-16 15:30:00
DNA Oyj	DNA Plc's Annual Report including Board of Directors' Report and full Financial Statements for 2016 is published	2017-03-01 17:00:22
Fiskars	Fiskars' Annual Report, financial statements and Sustainability Report for 2016 published	2017-02-15 16:30:00
Fortum	Fortum's operating and financial review and financial statements 2014 published	2015-02-20 13:00:00
	Fortum's 2015 reporting entity published	2016-02-25 14:00:00
	Fortum's Operating and Financial Review and Financial Statements 2016 published	2017-02-16 12:00:00
Huhtamäki Oyj	Huhtamaki's Annual Accounts and Directors' Report 2014 published	2015-02-19 13:00:00
Kemira Oyj	Kemira Annual Report 2015 published	2016-02-24 12:00:00
Konecranes Oyj	Konecranes Plc - KONECRANES PLC'S ANNUAL REPORT 2014 PUBLISHED TODAY	2015-03-03 14:00:01
	Konecranes Plc's Annual Report and Corporate Governance Statement 2016 published	2017-02-27 16:00:00
Metso Oyj	Metso's Annual Report and Corporate Governance Statement for 2014 published	2015-03-05 15:00:00
	Metso's Annual Report and Corporate Governance Statement for 2015 published	2016-02-26 15:00:00
	Metso's Annual Report and Corporate Governance Statement for 2016 published	2017-03-01 13:15:00
Metsä Board Oyj	Metsä Board's Annual Report for 2015 published	2016-02-26 13:00:00
	Metsä Board's 2016 Annual Report and Financial Statements published	2017-02-28 13:00:00
Neste Oil Oyj	Neste Oil's Annual Report, Corporate Governance Statement and Remuneration Statement for 2014 published	2015-03-03 12:15:00
Nokia	Nokia publishes its "Nokia in 2013" annual report and its annual report on Form 20-F for 2013	2014-04-30 14:30:11
	Nokia published its Nokia in 2014 annual report	2015-03-27 11:25:00
	Nokia published its Nokia in 2015 annual report	2016-04-01 14:30:00
Nordea Bank AB (publ.)	Nordean vuosikertomus ja vastuullisuusraportti	2016-02-16 13:15:00
	Nordean vuosikertomus ja vastuullisuusraportti julkaistaan tänään	2017-02-15 12:00:00
Orion	Orion Group Financial Statement documents 2016 and Corporate Governance Statement published	2017-02-27 13:00:00
Outokumpu Oyj	Outokumpu publishes 2014 Annual report and Sustainability report	2015-03-04 14:00:00
	Outokumpu publishes 2015 Annual report, Corporate Governance Statement and Sustainability report	2016-03-09 11:30:00
Outotec Oyj	Outotec's Financial Statements 2014 published	2015-02-27 12:00:00
	Outotec Oyj's Financial Statements 2015 and Corporate Governance Statement published	2016-02-26 13:59:04
	Outotec Oyj's Financial Statements 2016 and Corporate Governance Statement published	2017-03-01 16:03:43
Sanoma Oyj	Sanoma's Financial Statements and Board of Directors' Report 2016 Published	2017-02-27 14:55:00
SSAB AB	SSAB's Annual Report 2014 includes updated financial targets	2015-03-16 11:00:00
	SSAB's Annual Report 2015 published	2016-03-15 12:30:00

SSAB AB	SSAB’s Annual Report 2016 published	2017-03-13 15:15:00
Tieto	Tieto’s Financial Statements and Corporate Governance Statement 2014 have been published	2015-02-19 14:00:00
	Tieto’s Financial Statements and Corporate Governance Statement 2015 have been published	2016-02-24 12:00:00
	Tieto’s integrated Annual Report 2016 has been published	2017-03-01 12:00:00
Uponor	Uponor Corporation’s Financial statements 2014 report available	2015-02-19 14:15:00
	Uponor Corporation’s Financial statements 2015 report available	2016-02-22 17:00:00
Valmet	Valmet has published the Annual Report and the Corporate Governance Statement for 2015	2016-02-29 13:00:00
	Valmet has published the Annual Report and the Corporate Governance Statement for 2016	2017-03-01 13:00:00
YIT	YIT's Annual Report for 2015 published	2016-02-22 14:00:00