Journal of Financial Markets ▮ (▮▮▮▮) ▮▮▮–▮▮▮

Contents lists available at ScienceDirect

Journal of Financial Markets

journal homepage: www.elsevier.com/locate/finmar

Are trading imbalances indicative of private information? ☆

Sukwon Thomas Kim [a,1], Hans R. Stoll [b,*]

[a] School of Business Administration, University of California at Riverside, 900 University Avenue, Riverside, CA 92521, USA
[b] Owen Graduate School of Management, Vanderbilt University, Nashville, TN 37203, USA

ARTICLE INFO

Article history:
Received 15 July 2013
Received in revised form
13 March 2014
Accepted 13 March 2014

JEL classification:
G12
G14

Keywords:
Trading imbalance
Order imbalance
Informed trading
Private information
Earnings announcements
Mergers and acquisitions
Seasoned equity offerings

ABSTRACT

Trading imbalances are often interpreted to be the result of informed trading. Yet imbalances may simply reflect random shocks or the results of liquidity trading. If trading imbalances reflect informed trading, they should anticipate major news events. Using announcements of earnings, acquisition targets, and seasoned equity offerings as our information events, we examine whether prior trading imbalances are related to the subsequent news. We conclude that imbalances do not well reflect the information held by informed traders. Trading imbalances do have price effects, but they are contemporaneous and are not significantly correlated with the forthcoming announcements.

1. Introduction

How is information reflected in the price of securities? If information is public, it will (in an efficient market) be reflected immediately in prices even without trading. Alternatively, if information is private,

☆ We gratefully acknowledge the financial support of the Financial Markets Research Center at Vanderbilt University and access to the Center's data. We thank Bill Christie and Rick Smith for their helpful comments.

* Corresponding author. Tel.: +1 615 322 3674.
E-mail addresses: sukwonk@ucr.edu (S.T. Kim), hans.stoll@owen.vanderbilt.edu (H.R. Stoll).
[1] Tel.: +1 951 233 9206.

http://dx.doi.org/10.1016/j.finmar.2014.03.003
1386-4181/

it is impounded in prices by the trading of informed investors. Positive news will cause informed traders to purchase shares and increase the price, while negative news will encourage informed traders to sell shares and lower the price. The imbalance in trading, which is a reflection of private information, will push prices to reflect this private information. It is often assumed that trading imbalances are driven by information, but this is not necessarily the case. Orders may arrive randomly or may reflect liquidity needs that result in price effects solely from the price pressure of the imbalance. The extent to which trading imbalances are driven by information is an empirical question that is the focus of this study.

Suppose the researcher observes a purchase trading imbalance in a particular stock. One possibility is that informed traders are seeking to exploit their private information. Alternatively, the imbalance may be a random liquidity event that puts pressure on the inventories of dealers and other suppliers of liquidity. In both cases, the stock price would increase to reflect the increased demand. Our objective is to determine whether observed imbalances reflect private information. We consider corporate information events (earnings announcements, acquisition targets, and seasoned equity offerings) and examine whether imbalances before the event are indicative of private information. If information driven, one would observe a correlation between the imbalance and the subsequent information. A failure to find a correlation implies: (1) that private information is not present or (2) that trading on private information is not possible (e.g., because counterparties step away). Imbalances may continue to be present, but not for informational reasons.

The elements in our analysis – information, return and imbalances – depicted in Fig. 1 are the key variables whose response to a trading shock or an information shock we seek to understand. The links among the three variables are both contemporaneous and inter-temporal. Consider first the contemporaneous links of the three elements of our analysis.

Information about a security is ultimately reflected in returns. The path may be direct via link (a) if information is made public and impounded in the stock price. Alternatively, the link may be indirect via link (b) and link (c) if information is not public and is only slowly reflected in the price via trading. Trading by informed investors will generate imbalances that anticipate the news, and stock prices will adjust today to reflect any information in the imbalances. We assume that markets are efficient in the sense that current news or current order flow cannot predict abnormal future returns. Instead prices adjust immediately and may anticipate future announcements.

The inter-temporal link, which is the focus in this study, is the link between imbalances today and news announcements at a later date. If imbalances reflect private information as is often assumed, one should observe a correlation between the imbalance and the subsequent news. Alternatively, the imbalances may reflect random trading by noise traders unrelated to information. Stock returns today may reflect future news insofar as security analysts and other investors reflect public information in the price. In our empirical work, we control for stock returns in assessing whether an imbalance conveys information. The imbalance should have an effect net of the stock price change.

Easley, Kiefer, O'Hara, and Paperman (1996) and Easley, Kiefer, and O'Hara (1997) provide an elegant and simple model of the trading process for informed and uninformed investors. The model generates the probability of informed trading (PIN), which is directly inferred from the imbalance between buys and sells. Easley, Engle, O'Hara, and Wu (2008) document the similarity between PIN and the proportional imbalance. A finding that the spread is correlated with PIN has been taken to support the

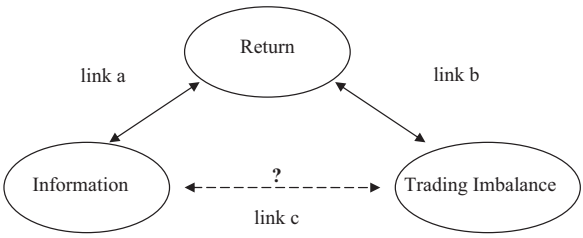

Fig. 1. Elements of the market.

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

adverse information theory of the spread on the grounds that PIN is related to informed trading imbalances. However, the imbalance may also come from non-informational sources. Duarte and Young (2009) find that the imbalance reflects liquidity. They conclude that the liquidity effect is priced. Andrade, Chang, and Seasholes' (2008) model the effect of non-informational imbalances on prices. In a comprehensive study of trading imbalances, Chordia and Subrahmanyam (2004) determine that there are price effects of imbalances, but they remain uncertain as to the exact sources of the imbalances.

In Appendix A, we describe the trading process of EKOP (2008)that is based on four parameters: (1) α, the probability of an information event; (2) δ, the probability that the information event contains bad news; (3) μ, the arrival rate of informed investors; and (4) ε, the arrival rate of uninformed investors. If purchases exceed sales, the implication of the EKOP (2008) model is that informed investors are adding to the buyers as they anticipate positive information. In the tree diagram, this is reflected in an arrival rate of $\varepsilon+\mu$. If information is the source of the imbalances, one should observe, given a large enough sample, an association between information and imbalances. EKOP (2008) estimate the parameters on the basis of the observed data on purchases and sales and find that these estimates are associated with the bid-ask spread of the stocks. One cannot conclude, however, that the source of the imbalance is private information.

An imbalance could reflect liquidity shocks and, as we illustrate in Appendix A, the same tree structure could be applied to analyze the effect of liquidity events. Positive trading imbalances could lead to the inference that positive private information had been discovered. However, positive imbalances could also lead to the inference that liquidity pressures change prices. Imbalance and return data alone are not sufficient to distinguish the two sources of price change. The only means by which to distinguish the two theories is to introduce information directly into the analysis. That is our approach. If imbalances are the result of informed traders acting on their information, we should find a link between the imbalance and the subsequent information. We find no such link, which suggests that the imbalances are not the result of informed trading.

We examine three types of information events: earnings announcements, takeover announcements, and announcements of seasoned equity offerings (SEOs). Our primary focus is on earnings announcements as this is the larger sample. Still, takeovers and equity offerings may show a different relation between information and imbalances because their announcements are not anticipated. Earnings announcements are regularly made every quarter, and contrarian retail investors may offset informed trades before the scheduled announcements. On the other hand, there could be fewer offsetting trades if an announcement is not anticipated.

A number of studies are on trading around earnings announcements. Bernard and Thomas (1990) use earnings surprise, the difference between actual earnings and predicted earnings, as a proxy for information. Recently, Kaniel et al. (2012) use earnings announcements to study the correlation between individual trading and private information. Campbell, Ramodorai, and Schwartz (2009) analyze institutional trading around earnings announcements. While these papers use *private* data on trading patterns, we use *public* trade data to calculate trading imbalances according to the Lee and Ready (1992) method.[2] We investigate whether the trading imbalances reflect private information about upcoming news announcements. Collin-Dufresne and Fos (2012) examine 13D filings. They assume the filers are informed investors, but find that trading on days around the 13D filing have a smaller price impact than on other days. They interpret their results as a major challenge to the adverse information models. Inci and Seyhun (2012) find that insider transactions are contrarian and have little price impact.

Using Fig. 1 as a framework, our findings can be summarized as follows:

1. Trading imbalances do not anticipate future announcements [link (c)]. This finding implies that imbalances are not a good indicator of private information.
2. The abnormal stock return is weakly related to the subsequent earnings announcement [link (a)], reflecting the ability of securities analysts to anticipate future earnings announcements.
3. Stock returns and imbalances are contemporaneously correlated [link (b)]. Given our finding that

[2] Kaniel et al. (2012) acquire private trading data from the NYSE. Campbell et al. (2009) develop regression techniques to estimate institutional trading patterns from trading imbalances and institutional holdings data.

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

information and lagged imbalances are not correlated, this result indicates that trading pressure, rather than information, generates trading imbalances.

The paper proceeds as follows. In the next section, we provide an analytical framework and develop our hypotheses. The data and method of analysis are described in Section 3. In Section 4, we determine that the news announcements in our sample are accompanied by significant price effects, which indicates that the announcements contain information. In Section 5, we conclude that news announcements are not well anticipated by prior imbalances. In Section 6, we classify earnings surprises into five ranks. Here, we find that imbalances are not more likely to be associated with subsequent significant news (as measured by the rank) than with normal news. In Section 7, a regression framework is used to determine whether the earnings announcements (measured by the earnings surprise) are anticipated by prior imbalances. We verify that the imbalances do not predict announcements. In Section 8, we examine whether imbalances trail the past information. We demonstrate that imbalances are not driven by the past information. In Section 9, we study the relation between stock returns and subsequent announcements, and we find a weak but monotonic relation between two. Section 10 shows that imbalances and returns are contemporaneously correlated. The main conclusions are in Section 11.

2. Trading imbalances, information, and prices

Stock price quotes reflect public information and the impact of trading by informed traders. Informed traders have private information, and because their information differs from that of the uninformed investor, trades will occur and prices will change. (Ultimately the information held by the informed investor will through trading be reflected in the price and trading will no longer take place.) Information may be anticipated by the public and be reflected in returns or it may be anticipated by informed investors and be reflected in imbalances. To examine whether observed imbalances are related to private information, we test Hypothesis 1:

H1. *The trading imbalance is uncorrelated with the subsequent announcements.*

We have considered trading imbalances that arise due to trading by informed investors and imbalances that arise because of liquidity shocks. In a third case, when information is publicly disseminated, traders simply adjust their quotes to reflect that information, and trading imbalances are less likely to arise. Instead, prices will adjust without an imbalance, and tomorrow's news is reflected in today's returns. Trading imbalances will not arise unless traders fail to adjust their quotes quickly enough. However, in an efficient market, quote adjustment should be faster than any trades.

This argument implies that in any semi-strong efficient market, public information will be converted to prices in a two-step procedure. In Step One, public information arrives and quotes adjust according to this information. In Step Two, trades then take place at the new quote levels. Such a two-step procedure implies that trades or imbalances are not necessary to establish unbiased prices from public information. Fleming and Remolona (1999) find such a two-step pattern in the Treasury bill market. Therefore, in Hypothesis 2 we test the relation between stock returns and subsequent information:

H2. *Stock returns are uncorrelated with forthcoming news announcements.*

In an efficient and competitive market, investors have every incentive to seek out information and trade on it before other investors do. Consequently, returns are likely to reflect upcoming information. In the absence of private information, prices will reflect current public information and imbalances will tend toward zero. The fact that stock returns reflect future announcements does not rule out the possibility that trading imbalances also reveal some additional information.

Fig. 2 illustrates the relation between imbalances and information. In Fig. 2a, private information generates imbalances because informed traders place orders at one side (bid or ask). Existing quotes are not fully adjusted to the orders as market makers do not know the information. As a result, informed orders are executed at one side, generating imbalances. On the other hand, Fig. 2b shows the

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

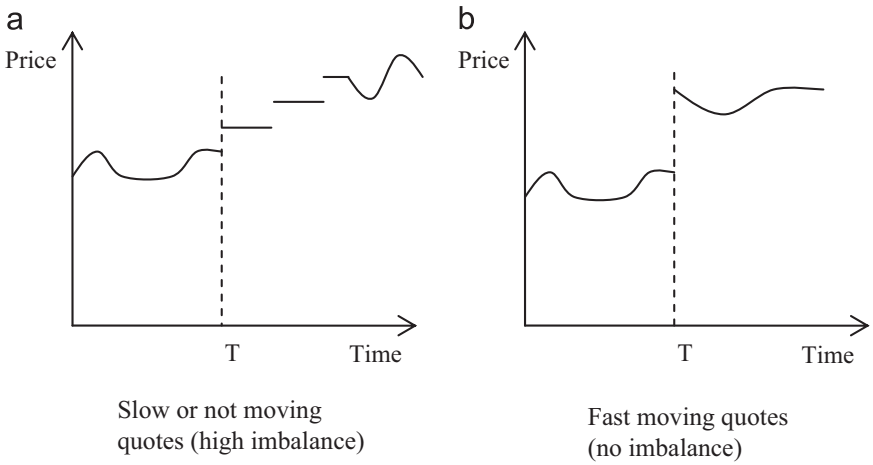

Fig. 2. Quotes, information, and imbalances. We compare two cases: (a) when market makers do not change their quotes according to positive information and (b) when they do. Trading imbalance will not reflect the value of public information if market makers change their quotes quickly.

case when quotes adjust according to information. Since quotes quickly adjust to a new price level that includes the value of information, there is no one-sided trading or imbalance. This case occurs when information is public and market makers reflect the information in their quotes.

In terms of Fig. 1, we have proposed hypotheses dealing with link (c), the relation between imbalances and the subsequent news, and with link (a), the association between returns and subsequent news. We now consider link (b), the correlation between imbalances and returns. Even if imbalances do not convey private information [via link (c)], they may arise for liquidity reasons. We examine this relation for our data set. Formally, we test Hypothesis 3:

H3. *Cumulated stock returns are uncorrelated with contemporaneous or lagged imbalances.*

The alternative hypothesis is that returns are correlated with imbalances. Such a correlation may occur if trading pressure moves prices. Prior research indicates that prices do respond to trades. Consequently, we expect to reject H3.[3] The price impact of trading is primarily contemporaneous with a lagged effect of opposite sign resulting from the temporary nature of a non-informational price impact.

3. Data and methods

Two types of data are required to implement the empirical work: (1) stock prices and returns, and (2) trading imbalances. We use Trade and Quote (TAQ) data for ordinary common shares from 1993 to 2010 to construct trading imbalances. The construction method is described in Appendix B, and it closely follows the method of Chordia, Roll, and Subrahmanyan (2002). Their method is based on Lee and Ready (1992), but it imposes additional filters to reduce problems due to infrequent trading. The basic logic is to compare trade price and prevailing quotes. If the trade price is closer to bid, it is classified as a sell-side transaction and vice versa. A buy-side trade has a positive sign and a sell-side trade has a negative sign. The signed trades are aggregated every day to calculate daily trading imbalance.

We report the results for trading imbalance in shares. We acquire qualitatively similar results for trading imbalance in dollars and number of trades. In our dataset, share trading imbalance and dollar trading imbalance have a 99% positive correlation, while the imbalance in trades has an 83% positive correlation with the other two measures. The trading imbalance for each stock and each day is

[3] See Kraus and Stoll (1972), Lin, Sanger, and Booth, (1995), Madhavan, Richardson, and Roomans (1997), Stoll (2000) for prior work.

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

normalized by dividing by the corresponding total daily stock volume (in shares, dollars, or number of trades, as appropriate). Our empirical section reports trading imbalances in number of shares, but the results are not affected by switching units (dollars or trades).

As in Chordia and Subrahmanyam (2004), price and return data are based on the mid-quote prices to remove the effect of bid-ask bounce. The mid-quote data come from the Market Microstructure Database constructed by the Financial Markets Research Center at Vanderbilt University.

As a measure of information, we choose announcements of three pieces of news: earnings, takeovers, and SEOs. Earnings information is measured by the surprise in the announcement. We use quarterly earnings announcements provided by *I/B/E/S* to measure the surprise for each analyst by the difference between the most recent earnings per share (EPS) forecast and the actual earnings. If the forecast is more than 90 days old or less than 15 days prior to the actual earnings announcement, we drop the forecast. We require stocks to have more than five recent forecasts, but we use only the forecast of the analyst with the most recent forecast as some analysts are slow to adjust their forecast to the latest information. The earnings surprise for a firm i in quarter q is then calculated as the difference between actual earnings and the latest forecast of earnings, divided by the latest forecasted earnings.[4] If actual earnings are larger (smaller) than expected, the surprise measure will have a positive (negative) sign.

$$Surprise_{i,q} = \frac{Actual\ EPS - Expected\ EPS}{|Expected\ EPS|}. \tag{1}$$

The importance of takeovers and equity offerings is measured by the stock price reaction. These announcements are known to have a significant impact on stock returns. The reactions are positive for acquisition targets and negative for SEOs. Informed investors are able to gain extra returns by trading before the announcements and their actions may be reflected in trading imbalances.

We collect data on acquisitions and SEOs from the SDC Database. Among the acquisition cases, we focus on target firms since their stock returns react strongly to the announcement. Alternatively, the stock returns of acquiring firms may report mixed reactions according to the nature of the acquisition. We exclude partial acquisitions where less than 100% of a stock is acquired. We follow the classification in the SDC Database to remove partial acquisitions. The sample period is from 1993 to 2010. We further restrict targets and equity offerings to firms for which TAQ data are available. Unlike earnings announcements, which vary in magnitude, acquisitions and equity offerings are discrete events. Therefore, we investigate whether trading imbalances for the event firms demonstrate a significantly different pattern from other non-event firms.

4. Announcement price effects

We examine first if the announcements we have chosen are significant as measured by their abnormal returns. In Fig. 3a–c, abnormal returns are plotted around the announcement day for each of the three events. Abnormal return is defined as the difference between individual mid-quote stock returns and equal-weighted market wide returns.[5] As expected, a significant abnormal return is observed for each announcement. For example, Fig. 3a illustrates that earnings announcements produce significant

[4] We used other measures of earnings surprise, but the results were unaffected. For example, Mendenhall (2004) and others define earnings surprise as the difference between actual earnings and average analyst EPS forecasts, divided by the standard deviation of the forecasts:

$Surprise_{i,q} = \frac{Actual\_Earnings_{i,q} - \overline{Exp\_Earnings_{i,q}}}{STD(Exp\_Earnings_{i,q})}$, where i is one firm and q is one quarter.

We also use earnings ranks as recommended by Bernard and Thomas (1990) to account for non-linearity and outlier problems. Mendenhall (2004) suggests ranking earnings surprise into 11 ranks and then dividing by 11 and subtracting 0.5 from the variable. The ranked earnings surprise variable has its mean around 0, and 0.1 is the difference between two close ranks. The results were unaffected by the use of ranks and are not reported here.

[5] We also tried normalization by size. The individual return is normalized by the average return of the same size decile. We find no material difference in results.

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

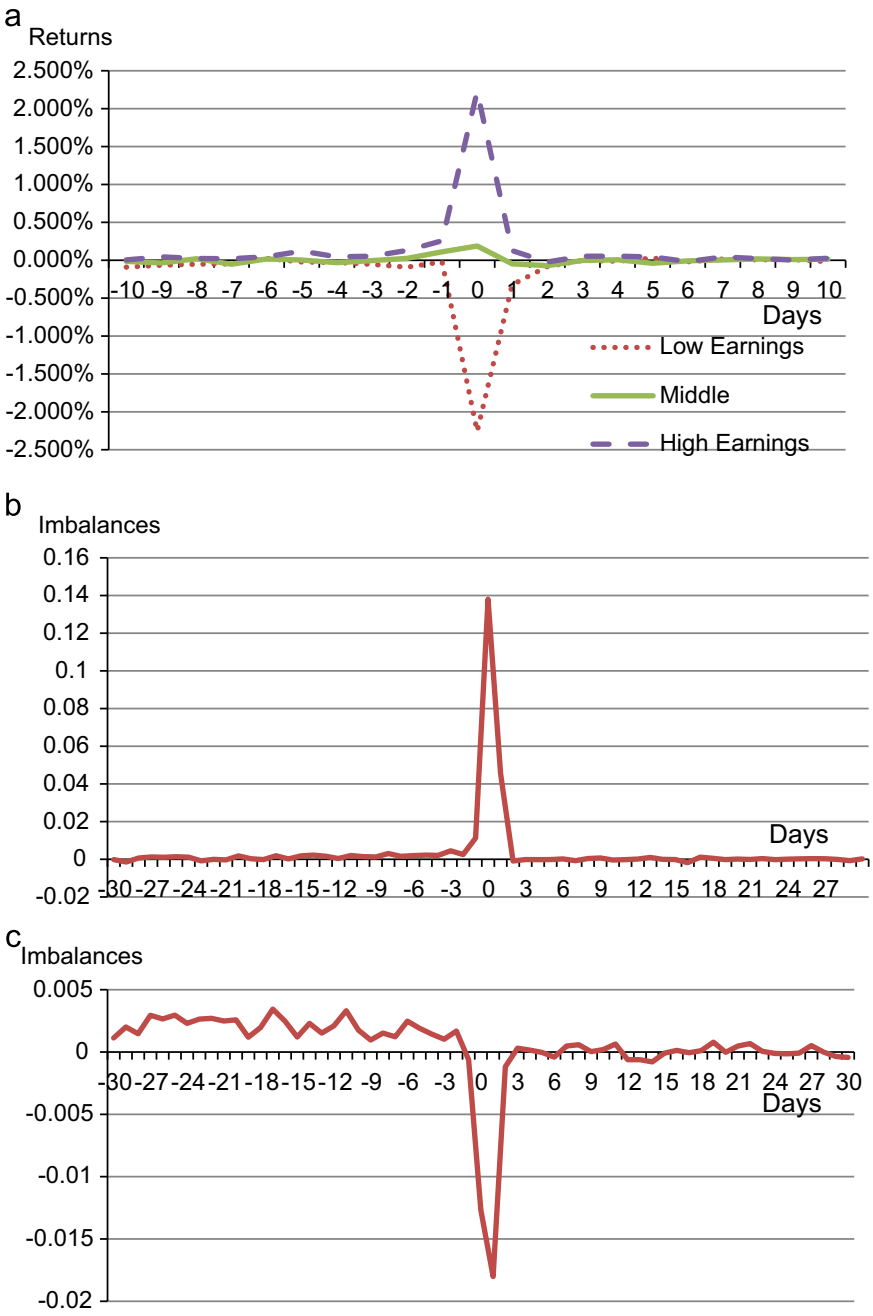

Fig. 3. (a) Excess mid-quote stock returns around earnings announcements, (b) Excess mid-quote stock returns around acquisition announcements: target firms and (c) Excess mid-quote stock returns around SEO announcements.

differences in stock returns around announcement dates. The difference between the high earnings surprise group and the low earnings surprise group is approximately 4% at the announcement date.

In Table 1, we characterize our imbalance and return data. Among all the firms that have trading imbalances data from TAQ, there are 53,698 earnings announcements for 1,360 firms, 1,306 takeovers,

Table 1
Imbalances and announcement. Summary statistics.
Daily data: 1993–2010.
Daily trading imbalances are calculated using the Lee and Ready (1992) method and additional filters used in Chordia, Roll, and Subrahmanyan (2002) are imposed. See Appendix B concerning the filters. Daily trading imbalances are normalized by daily volume, dollar volume, or number of trades. Daily mid-quote returns are derived from daily volume-weighted average bid and ask prices. Earnings surprise is defined as the difference between actual earnings per share and the most recent analyst earnings per share, divided by the analyst earnings per share.

	Mean	Median	Std. dev.	Obs.
Daily trading imbalance, shares (all firms)	−0.007	−0.014	0.188	
Earnings announcement:				
Earnings surprise	0.002	0.037	5.208	53,698
Number of firms	4,004			
Number of analyst reports per announcement	11.00	9.00	5.23	
Daily trading imbalance, shares (−30, +1 around earnings announcements)	−0.008	−0.014	0.186	
Mid-quote return (−1, +1 excess cumulative mid-quote return around announcement date)	0.147%	0.007%	8.591%	
Takeover announcement: (−1, +1 excess cumulative mid-quote return around announcement date)	19.281%	16.188%	20.486%	1,306
SEO announcement: (−1, +1 excess cumulative mid-quote return around announcement date)	−3.185%	−2.664%	7.279%	5,515

and 5,515 announcements of SEOs. The average trading imbalances of the whole sample (all event and non-event firms that have trading imbalances data) is near zero. The daily standard deviation of the whole sample is 0.188, or 18.8% of daily volume, which indicates considerable variability in trading imbalances.

Table 2 Panel A provides statistics regarding returns on and around the announcement days. The average stock return over positive and negative earnings announcement is near zero, but our interest is in the cross-sectional variation in earnings surprises, which is quite substantial. Acquisition announcements (Panel B) have positive stock price reactions averaging +19% in the (−1, +1) window of the announcement date and SEO announcements (Panel C) have negative stock price reactions of about −3% in the event window.

Earnings announcement effects are examined in more detail in Table 3. Firms are ranked by earnings surprise into ten categories, and abnormal returns are computed for each category over three days and over ten days around the announcement day. The table indicates that there is cross-sectional variation in the abnormal return: positive for positive earnings surprises and negative for negative earnings surprises. The difference between the highest and lowest three day abnormal returns is 6.92%, which is statistically significant. We conclude that earnings announcements have a significant price effect, which implies that information is being conveyed to the market. The return data around the announcement dates of takeovers and SEOs illustrated in Fig. 3b and c also exhibit significant stock price reactions.

5. Imbalances prior to news announcements

Direct evidence of private information prior to an announcement is generally not available. Instead, researchers often use trading imbalances as a measure of the existence of private information. We examine the size and sign of the imbalances for each stock in the period prior to the announcement. If imbalances are indeed caused by informed trading, we expect to observe that the imbalances are related to the subsequent announcement. In Fig. 4a–c, we plot trading imbalances preceding earnings announcements, takeover announcements, and announcements of SEOs. Since trading imbalances do not have zero means around earnings announcements (Table 1), we normalize the imbalances by subtracting the daily average of trading imbalances around earnings announcements.

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

Table 2
Trading imbalances and stock returns for three days before and after announcements.

Panel A. Earnings announcements

	D−3	D−2	D−1	D−0	D+1	D+2	D+3
Trading imbalances							
Average	−0.008	−0.007	−0.002	−0.001	−0.004	−0.010	−0.009
Std. dev.	0.184	0.184	0.181	0.166	0.174	0.179	0.181
Mid-quote stock returns							
Average	0.015%	−0.001%	0.079%	−0.091%	−0.097%	−0.064%	−0.021%
Std deviation	3.10%	3.12%	3.45%	7.19%	4.05%	3.46%	3.26%

Panel B. Acquisition announcements

	D−3	D−2	D−1	D−0	D+1	D+2	D+3
Trading imbalances							
Average	0.020	0.036	0.051	−0.058	−0.131	−0.123	−0.122
Std Deviation	0.312	0.316	0.314	0.28	0.274	0.31	0.317
Mid-quote stock returns							
Average	0.352%	0.254%	1.107%	13.857%	4.558%	−0.091%	−0.016%
Std deviation	3.278%	2.818%	4.280%	17.471%	11.727%	2.192%	2.055%

Panel C. SEO announcements

	D−3	D−2	D−1	D−0	D+1	D+2	D+3
Trading imbalances							
Average	0.014	0.01	0.018	−0.011	−0.008	0.005	0.012
Std Deviation	0.260	0.263	0.264	0.263	0.244	0.255	0.256
Mid-quote stock returns							
Average	0.103%	0.146%	−0.058%	−1.255%	−1.803%	−0.117%	0.032%
Std deviation	3.420%	3.209%	3.570%	4.584%	4.777%	3.474%	3.374%

Table 3
Cumulative abnormal stock returns around earnings announcements.
We define abnormal stock returns as the difference between a stock return and an equal-weighted market return. We cumulate the abnormal returns in (−1, +1) day window or (−5, +5) day window around earnings announcements. We rank earnings surprises into deciles and report average cumulative abnormal return by the deciles. *Significant at the 1% level.

Earnings surprise rank	(−1,+1) Cumulative abnormal return	Std. error	(−5,+5) Cumulative abnormal return	Std. error
Low (most negative)	−3.57%	0.14%	−3.82%	0.19%
2	−2.71%	0.12%	−2.98%	0.17%
3	−1.83%	0.11%	−2.06%	0.14%
4	−0.98%	0.09%	−1.26%	0.12%
5	−0.04%	0.09%	−0.14%	0.12%
6	0.84%	0.10%	0.60%	0.12%
7	1.41%	0.10%	1.44%	0.13%
8	2.31%	0.11%	2.60%	0.15%
9	2.64%	0.12%	3.16%	0.16%
High (most positive)	3.35%	0.14%	3.97%	0.18%
Difference between highest and lowest	6.92%*	0.20%	7.79%*	0.26%

Fig. 4a shows that the imbalance effect appears at Day−1 and Day 0 for the high earnings group but is quite small. One would also expect informed traders to trade earlier. The largest trading imbalance of approximately 0.01, which occurs on Day−1, is still not statistically significant. Trading imbalances have daily standard deviations of 0.188 around earnings announcement dates (Table 1).

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

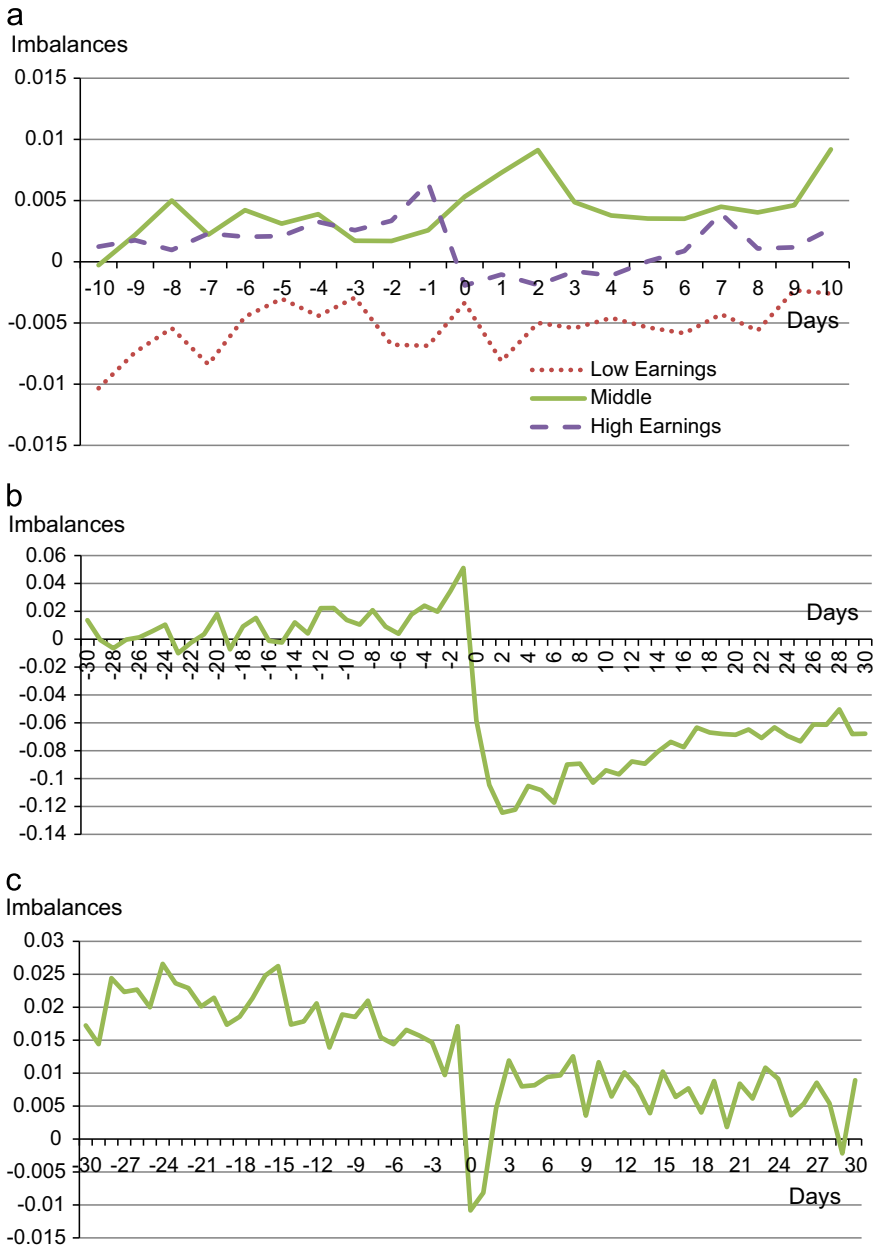

Fig. 4. (a) Trading imbalances around earnings announcements, (b) Excess trading imbalances around acquisition announcements: target firms and (c) Excess trading imbalances around SEO announcements.

Daily trading imbalances are plotted around the announcement dates of takeovers (Fig. 4b) and around the announcement dates of SEOs (Fig. 4c). The figures do not provide evidence that the imbalances anticipate the news. Excess trading imbalances of acquisition targets tend to be positive before the announcement dates, but the average size of the trading imbalances is small compared to the daily standard deviation of trading imbalances (Table 1). The imbalances shift from positive

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

to negative at the announcement date, but there is no indication that imbalances anticipate the announcement. Instead, takeover announcements are contemporaneous with imbalances. Average excess trading imbalances before announcements of SEOs are positive, and the sign of the imbalances is inconsistent with the negative effect of the SEO announcements.

We tested several methods to filter out any pattern from trading imbalances, such as cumulative trading imbalances, the median of imbalances, or logit/probit regressions. None of these methods provide evidence that trading imbalances predict forthcoming announcements.

Overall, trading imbalances do not consistently predict events. There is a tendency for imbalances to spike down (see Fig. 4b and c) at the time of the announcement, which suggests that trading imbalances and stock returns are contemporaneously correlated. The evidence indicates that traders' trade with the news, not in anticipation of it.

6. Important information and important trading imbalances

Some earnings announcements or other corporate announcements may not be of sufficient importance to attract interest from informed investors. If this is the case, potentially informed investors may not be active in the stock prior to the announcement period. In this section, we classify stocks into categories that reflect the importance of the earnings announcement and investigate whether more important announcements are more likely to be preceded by imbalances. We also examine this correlation by conditioning on imbalances, and try to determine whether large imbalances are more likely to anticipate future announcements. We collect data on the top ten imbalances for each day prior to the announcement to assess whether the announcement reflects the information implied by large imbalances.

6.1. Important news

First, we identify important earnings surprises by ranking earnings surprises into five categories (Low, 2, 3, 4, High). The ranking is done every quarter. A low rank indicates that earnings are less than anticipated, while a higher rank implies that earnings are more than anticipated. Recall that the low category and high category have the largest stock return reactions, as we document in Table 3. The average of earnings surprise is near zero (Table 1). The low category contains negative earnings surprises, while the high category contains positive earnings surprises. For each category, the average daily trading imbalance is calculated. In Fig. 5, we plot the cumulative trading imbalance starting 30 days before the earnings announcement and ending 30 days after the earnings announcement for each earnings rank.

One would expect that the category with the highest earnings surprise to have the largest positive trading imbalance and the category with the lowest earnings surprise to have the largest negative trading imbalance as informed investors would have the highest incentives to trade prior to the

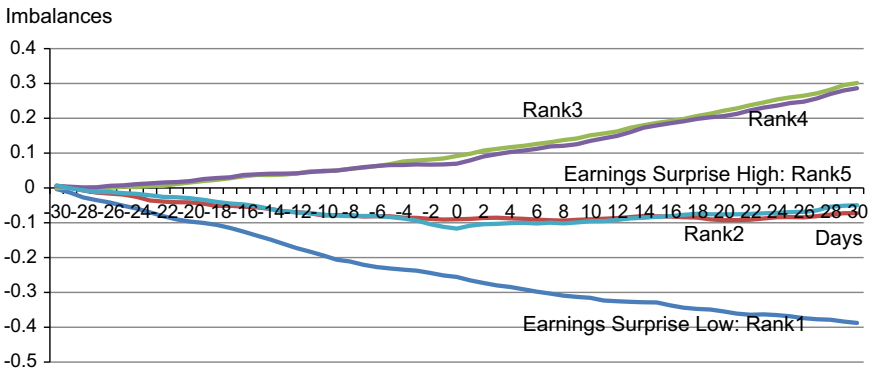

Fig. 5. Cumulative trading imbalances around earnings announcements.

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

Table 4
Trading imbalances before earnings announcements (Daily statistics).

We rank (−1, +1) cumulative abnormal return around earnings surprises into quintiles and report the daily average of the trading imbalances by the quintiles. In order to center imbalance values near zero, we subtract the equal-weighted, market-wide daily trading imbalances of earnings announcement firms from individual imbalances. We report the equal-weighted average of each group. Standard errors are in parentheses. *Significant (1% level) daily imbalances or differences between highest and lowest rank.

	Daily trading imbalances							
(−1, +1) Cumulative abnormal return	**D−8**	**D−7**	**D−6**	**D−5**	**D−4**	**D−3**	**D−2**	**D−1**
Lowest	−0.005	−0.003	−0.004	−0.004	−0.003	−0.002	−0.001	−0.022
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.002)
2	0.004	0.003	0.002	0.003	0.004	0.005	0.004	−0.007
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.002)
3	−0.001	0.004	0.003	0.005	0.005	−0.001	0.002	−0.001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.005)
4	0.006	0.001	0.005	0.002	0.001	0.002	0.002	0.010
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.002)
Highest	−0.005	−0.006	−0.005	−0.006	−0.005	−0.003	−0.005	0.021
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.005)	(0.002)
Highest − Lowest	0.000	−0.003	−0.001	0.002	−0.002	−0.001	−0.004	0.043*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.008)	(0.002)	(0.002)

announcements. We do not find this expected monotonic relationship between trading imbalances and earnings surprises. For example, high earnings surprise stocks have negative cumulative trading imbalances that fall below Ranks 3, 4, and 2, while they should be above these other categories. We observe the highest trading imbalances from earnings surprise Rank 3. However, this category should fall in the middle according to the theory that imbalances convey information. These data, like the data in Fig. 4, do not imply a correlation between imbalances and earnings surprises. The only rank that is consistent with the forthcoming earnings surprise is Rank 1 (lowest).

To supplement Fig. 5, daily trading imbalances for each of the eight days prior to the earnings announcement are tabulated in Table 4. In Table 4, we rank announcements into quintiles using the three day (−1, +1) abnormal cumulative return around earnings announcement dates.[6] For most days, imbalances give little indication of the magnitude of the subsequent announcement return. We only observe a significant difference in daily trading imbalances on Day−1, when it would be too late to benefit from earnings information. Additionally, the largest trading imbalances are observed in earnings surprise Rank 3 (middle) instead of Rank 5 (highest).

Acquisition announcements and SEO announcements were examined in the same way in Table 5. Important announcements are classified as the top or the bottom tercile of stock returns (top for the acquisition targets and bottom for the SEO firms). The ranking is done each calendar year.

Daily trading imbalances for the top stock return category at the announcement date (−1, +1) are plotted in Fig. 6a (acquisition targets) and Fig. 6b (SEO firms). Note that the imbalances for the largest stock return category are not much different from the average cases depicted in Fig. 4. There is no indication of informed trading prior to the announcement dates. In Table 5, we report non-cumulative and cumulative trading imbalances before acquisition and SEO announcements. Table 5 demonstrates that important news is not preceded by the largest trading imbalances. In fact, most of the imbalances are not significantly different from zero. Trading imbalance signs are the opposite of the announcement return signs for SEO announcements (i.e., trading imbalances are mostly positive for SEO announcements that have negative stock price reactions). Further, differences between the categories are largely insignificant, which indicates that trading imbalances do not reflect the quality of the forthcoming information.

[6] Results are similar when we use the size of earnings surprises, as in Fig. 4.

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

Table 5
Abnormal trading imbalances before acquisition announcements and SEO announcements.

We rank acquisition announcements and SEO announcements into three categories by cumulative excess stock returns at the (−1, +1) window of the announcement date. Excess returns are mid-quote stock returns over equal-weighted market wide average returns. Abnormal daily trading imbalance is defined as the difference between the individual daily trading imbalances and the equal-weighted market wide daily trading imbalance. We report an equal-weighted average imbalance in each importance category and for eight days prior to the announcement. Also reported are the 30-day and 10-day cumulative imbalance up to D-5. Standard errors are in parentheses. *Significant (1% level) daily imbalances or differences between highest and lowest rank.

Panel A: Acquisition announcements

Importance (measured by event day −1, +1 stock return)	Abnormal daily imbalance by day relative to announcement day								30-day Cumulated trading imbalances at D-5	10-day Cumulated trading imbalances at D-5
	D−8	D−7	D−6	D−5	D−4	D−3	D−2	D−1		
Lowest importance	0.040	0.013	0.022	0.022	0.040	0.029	0.013	0.038	0.28	0.20
	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.016)	(0.14)	(0.07)
Middle	0.039	0.015	0.005	0.024	0.034	0.011	0.051	0.065	0.28	0.16
	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.014)	(0.13)	(0.06)
Highest importance	−0.004	0.009	−0.014	0.007	−0.005	0.022	0.041	0.053	−0.06	−0.03
	(0.018)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.017)	(0.016)	(0.15)	(0.07)
Highest − Lowest	−0.044	−0.006	−0.036	−0.015	−0.045	−0.007	0.028	0.015	−0.34	−0.23
	(0.023)	(0.024)	(0.024)	(0.023)	(0.024)	(0.023)	(0.023)	(0.023)	(0.21)	(0.10)

Panel B: SEO announcements

Importance (measured by event day −1, +1 stock return)	Abnormal daily imbalance by day relative to announcement day								30-day Cumulated trading imbalances at D-5	10-day Cumulated trading imbalances at D-5
	D−8	D−7	D−6	D−5	D−4	D−3	D−2	D−1		
Lowest importance	0.020*	0.015	0.012	0.008	0.012	0.014	0.019	0.075*	0.63*	0.17*
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.06)	(0.03)
Middle	0.030*	0.025	0.021*	0.019*	0.022*	0.027*	0.019*	0.016	0.78*	0.24*
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.06)	(0.03)
Highest importance	0.015	0.006	0.012	0.022*	0.013	0.002	−0.009	−0.037*	0.41*	0.15*
	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.006)	(0.06)	(0.03)
Highest − Lowest	−0.005	−0.009	0.000	0.014	0.001	−0.012	−0.028*	−0.112*	−0.18	−0.02
	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.009)	(0.08)	(0.04)

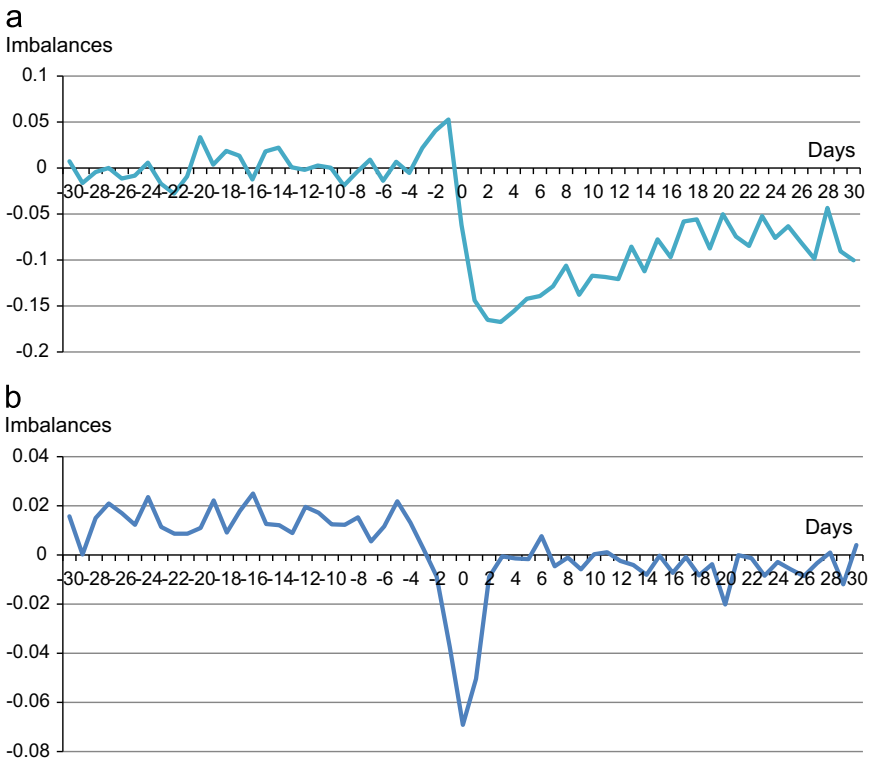

Fig. 6. (a) Excess trading imbalances in target firms' stocks around 33% largest stock return reactions to acquisition announcements and (b) Excess trading imbalances around 33% largest stock return reactions to SEO announcements.

6.2. *Important imbalances*

It is possible that imbalances were found to have little predictive power because we have focused on average imbalances by terciles or quintiles, which may be a too broad group. To deal with this issue, we target the ten largest positive and negative imbalances in each stock in the 20-day period prior to an announcement. Do the very largest imbalances anticipate news announcements? The results can be found in Table 6. The table reports that the ten largest imbalances do not anticipate a material difference in announcement returns. Large imbalances prior to an earnings announcement predict similar positive announcement returns regardless of their sign (positive or negative). Similarly, the imbalance prior to a takeover announcement is not associated with the magnitude of the event returns. Actually, acquisition announcement returns are 5% higher in most negative trading imbalances. Consistent with our results, Atkas et al. (2007) find no particular movement of trading imbalances prior to M&A announcements. Extreme negative imbalances in SEOs produce event returns lower than that of extreme positive imbalances. However, the difference between the two returns (0.8%) is not statistically significant due to the large standard deviation of returns among these extreme imbalance firms. Overall, there is not enough evidence to conclude that trading imbalances anticipate corporate event returns.[7]

[7] In Table 6, cumulative order imbalances are measured at five business days before the announcement date. We do not note significant differences when we vary the measurement point between two and ten business days prior to the announcements. This insensitivity to the measurement point also holds in our subsequent analyses.

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

Table 6
Do large imbalances anticipate news?

We normalize individual daily trading imbalances by subtracting equal-weighted market-wide daily trading imbalances. The 30-day cumulative, normalized trading imbalances are measured before the event date at t–5. The ten largest imbalances are retained each calendar year and the cumulative excess announcement returns $(-1, +1)$ associated with these imbalances are tabulated. Excess return is defined as the difference between individual stock returns and the equal-weighted market wide returns. The last column compares the returns by taking the difference in returns. Standard error of the difference is in the parentheses.

	Ten largest positive prior imbalances	Ten largest negative prior imbalances	Difference in returns
Earnings announcement			
Average cumulative abnormal stock return in $(-1,+1)$ event window	1.91%	1.40%	0.51%
Standard deviation of return	15.27%	13.49%	(6.44%)
t-Value of the average return	1.73	1.43	
Takeover announcement			
Average cumulative abnormal stock return in $(-1, +1)$ event window	14.46%	19.33%	−4.87%
Standard deviation of return	15.75%	19.86%	(8.01%)
t-Value of the average return	11.97	12.66	
SEO announcement			
Average cumulative abnormal stock return in $(-1, +1)$ event window	−2.20%	−3.03%	0.83%
Standard deviation of return	5.58%	8.44%	(3.20%)
t-Value of the average return	−5.28	−4.81	

7. Are trading imbalances related to subsequent news? A regression approach

Non-parametric methods adopted in the previous section may not be sophisticated enough to filter out the predictive power of trading imbalances. As such, we proceed with a regression approach and focus on earnings announcements to assess whether imbalances anticipate the announcements. We estimate the following regression using daily data for days $(t-20, t-2)$ prior to the earnings announcement day:

$$\Delta h_{it} = \alpha + \delta_1 TI_{i,t-1} + \delta_2 r_{i,t-1} + \varepsilon_{i,t,} \tag{2}$$

where Δh_{it} is the size of the information announcement for stock i made after day t. Our information event is the surprise component in company earnings announcements. Let E_t be the earnings at time t and E^*_{t-1} be the expected earnings. The surprise in earnings is defined as $(E_t - E^*_{t-1})/E^*_{t-1}$.[8] $TI_{i,t-1}$ is the expected cumulated trade imbalance in stock i for one or more days prior to day t. Trading imbalances are expressed in relative terms: $TI_{i,t} = B_{it} - S_{it}/B_{it} + S_{it}$, where B_{it} and S_{it} are purchases and sales, respectively, in stock i. Lags of 5, 10, and 20 days are used in our empirical work. $r_{i,t}$ is the stock's return on the prior and lagged days. This variable is used to account for public anticipation of the earnings announcement in the prior market return.

Observations are pooled across stocks relative to Day t–2.[9] We test Hypothesis 1: The trading imbalance is uncorrelated with the subsequent information. The null is rejected if δ_1 in Eq. (2) is positive and significant. In that instance, we accept the alternative hypothesis that imbalance is correlated with the value of forthcoming information. There are two things to note in Eq. (2). First, the coefficient of trading imbalance is likely to vary by company size (Stoll, 2000) or by other stock

[8] As a robustness check, we also use abnormal stock returns around earnings announcement dates instead of earnings surprises. We find similar results after switching the dependent variable.

[9] We test other pooling periods ranging from day-to-day regressions to the 30 business day aggregate. We also vary the time of pooling from −2 days to −10 days. We do not find our results changed much by the pooling method.

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

Table 7
Trading imbalances and earnings surprises (Pooled regression result).

We use all earnings surprises in our sample to estimate the following regression:

$$\Delta h_{it} = \alpha + \delta_1 \, TI_{i,t-1} + \delta_2 \, r_{i,t-1} + \varepsilon_{i,t}, \quad (2)$$

where Δh_{it} is the amount of the information announcement for stock i on day t deflated by the latest earnings forecast and TI_{it} is the cumulative trading imbalance in stock i on day t. $r_{i,\,t-j-1}$ is the stock's return on the prior day and lagged days. j indicates the time between the forthcoming information announcement and the current trading imbalance. Each earnings surprise is a separate observation. In the second column of each regression, we report the results when imbalances are used as the single explanatory variable. The regression is estimated with the pooled data of all earnings surprises. We use OLS regression with clustering and heteroscedasticity controlled error structure. We control for clustering by stock, year, and quarter. *T*-values are in the parentheses. Coefficients significant at the 1%, 5%, and 10% levels are marked with ***, **, and *.

Panel A: Using 5-day moving sum of trading imbalances

	Regression 20 days before announce		Regression 10 days before announce		Regression 5 days before announce	
Five-day moving sum of trading imbalances (δ_1)	0.004	0.015	−0.025	−0.026	−0.003	0.012
	(0.18)	(0.67)	(−0.87)	(−0.99)	(−0.10)	(0.36)
Five-day moving sum of stock return (δ_2)	0.487		−0.017		0.673**	
	(1.29)		(−0.05)		(2.91)	
Observations	52,738	52,761	53,422	53,434	53,451	53,277
Adj. R^2	0.01%	0.00%	0.00%	0.00%	0.01%	0.00%

Panel B: Using 10-day moving sum of trading imbalances

	Regression 20 days before announce		Regression 10 days before announce		Regression 5 days before announce	
10-day moving sum of trading imbalances (δ_1)	0.007	0.016	−0.018	−0.010	−0.020	−0.005
	(0.52)	(1.38)	(−0.84)	(−0.52)	(−0.28)	(−0.28)
10-day moving sum of stock return (δ_2)	0.577*		0.471		0.001	
	(1.76)		(1.40)		(0.79)	
Observations	52,738	52,761	53,422	53,434	53,451	53,456
Adj. R^2	0.02%	0.00%	0.02%	0.00%	0.00%	0.00%

Panel C: Using 20-day moving sum of trading imbalances

	Regression 20 days before announce		Regression 10 days before announce		Regression 5 days before announce	
20-day moving sum of trading imbalances (δ_1)	0.005	0.005	−0.004	−0.004	−0.004	−0.004
	(0.89)	(0.89)	(−0.31)	(−0.31)	(−0.37)	(−0.37)
20-day moving sum of stock return (δ_2)	0.002***		0.001**		0.001*	
	(5.06)		(1.99)		(1.72)	
Observations	52,555	52,578	53,422	53,434	53,451	53,456
Adj. R^2	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%

characteristics.[10] Thus, we group stocks by size and by other characteristics. Additionally, trading imbalances must be aggregated over time as it is unlikely that the trading imbalance for a particular day will capture the trading of informed investors. Eq. (2) is implemented by calculating the average over alternative time periods extending up to 20 days.

The regression method is OLS with a clustering and heteroscedasticity controlled error structure. We control for clustering by firm, year, and quarter. Petersen (2009) finds that such correction yields consistent estimators for panel data sets. Since we do not know when informed investors might

[10] Stoll (2000) finds that the correlation between a stock's price change and the order imbalance is a function of company size. In Eq. (2), the dependent variable is the information in the announcement, which we expect to bear a similar relation to company size.

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

establish a position, we examine, in separate regressions, the association between the earnings surprise and the imbalance for lags of 5, 10, and 20 business days.[11]

The results are presented in Table 7. The coefficient of lagged *TI* is not statistically significant in any of the nine regressions. The *t*-values are all less than one and the adjusted *R*-squares are tiny. Furthermore, even a *t*-value of 2.0 would overstate the significance given that there are over 50,000 observations.[12]

The coefficient of the lagged stock return variable has a significant *t*-value in two of nine cases in Table 7. A stronger link had been expected as one assumes that securities analysts carry out research that would cause returns today to anticipate future news at least in part.

As a second test, we take the unexpected announcement day return, $r_{i,t}$, as a measure of the value of the information revealed on the announcement day and regress the return on prior imbalances and prior returns. We find a similar weak relation between imbalances and announcement day returns. Results are available upon request.

The estimates in Table 7 may fail to account for the differences across stocks in their sensitivities to trading imbalances. To address this issue, we estimate Eq. (2) for groups of stocks categorized by measurable characteristics such as firm size, the size of the absolute imbalance, the sensitivity of the return to imbalance (the lambda coefficient), and the sign of the earnings surprise. Firm size, measured by stock market capitalization, tends to control for differing information environments in that large stocks attract more analysts and investors. The size of an imbalance would capture any tendency for large imbalances to better anticipate earnings announcements. The lambda coefficient is estimated by regressing daily stock returns against daily trading imbalances for one year. The equation is

$$r_{it} = \alpha + \lambda_i TI_{it} + \varepsilon_{it}, \tag{3}$$

where r_{it} is the daily return of stock i on day t and TI_{it} is the daily trading imbalances in stock i. Categorizing by the sign of the earnings surprise is intended to capture the differential effects of good news versus bad news, as well as possible restrictions to short selling. The results are found in Table 8.

The grouping procedure has little effect on the coefficients. There are a few statistically significant coefficients with *t*-stats near 3.0, but *R*-square, as before, is usually less than 1%. When we separate our sample by earnings announcement signs in Panel D in Table 8, we get a significant coefficient, but with the wrong sign (*t*-value $= -4.96$ for positive earnings surprises). Earnings announcements and imbalances should move together. Consequently, we do not change our basic conclusion that imbalances do not provide the investor or researcher with useful information regarding future news.[13]

8. Do imbalances trail past announcements?

Post earnings announcement drift (PEAD) is the phenomenon that stock returns trail the past earnings announcements (Bernard and Thomas, 1990). Several studies, such as Kaniel et al. (2012), find abnormal returns when trades are based on the past earnings information. A natural question is whether trading imbalances after announcements behave in the same way. One often observes a contemporaneous relation between imbalances and announcements. For example, Fig. 4b and c show shifts in imbalances at announcement points. To test if imbalances trail the past information, we plot cumulative trading imbalances from Day+2, which is after the announcement day reaction. Fig. 7a shows imbalances after earnings announcements. We find that the post-announcement imbalance patterns are similar to the pre-announcement patterns. Thus, imbalance patterns around earnings

[11] Results from other lags resemble the result of their close neighbors. For example, the result of lag 6 is similar to that of lag 5.

[12] When testing a specific hypothesis against a diffuse alternative, the number of observations affects the test. Lindley (1957) has demonstrated that the significance is overstated. This is known as Lindley's paradox. Huang and Stoll (1994) also discuss this issue. The issue may be relevant in Table 7 with respect to the imbalance variable. Some of the coefficients on the stock return variable appear to be significant, but according to Lindley's paradox, they are not.

[13] In an un-tabulated result, we examine whether an investor can earn additional stock returns by trading on past order imbalances. This approach is a non-parametric test and less subject to model specification problems. We find no significant difference in portfolio returns sorted by past order imbalances, consistent with our earlier results.

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

Table 8
Trading imbalances and earnings surprises (Subsamples by stock characteristics).

The sample is divided into quintiles by different stock characteristics. For each quintile, the following regression is estimated:

$$\Delta h_{it} = \alpha + \delta_1 TI_{i,t-1} + \delta_2 r_{i,t-1} + \varepsilon_{i,t}, \quad (2)$$

where Δh_{it} is the amount of the information announcement for stock i on day t deflated by the latest earnings forecast and TI_{it} is the cumulative trading imbalance in stock i on day t. $r_{i,\,t-j-1}$ is the stock's return on the prior day and lagged days. j indicates the time between the forthcoming information announcement and current trading imbalance. We report results for the 20-day moving sum of trading imbalances and stock returns measured five business days before the earnings announcement dates. The results vary by the length of aggregation and the time of measurement, but they are qualitatively similar. We use OLS regression with clustering and heteroscedasticity controlled error structure. We control for clustering by stock, year, and quarter. *T*-values are in parentheses. Coefficients significant at the 1%, 5%, and 10% level are marked with ***, **, and *.

Panel A: Quintile by firm market value

Size quintile	Intercept	δ_1	δ_2	*R*-square
1 (smallest)	−0.136*	−0.019	1.457	0.10%
	(−1.76)	(−0.50)	(1.36)	
2	−0.008	0.003	0.013**	0.00%
	(−0.20)	(0.35)	(2.70)	
3	0.034	0.006	0.134	0.01%
	(1.12)	(0.41)	(1.00)	
4	0.071	−0.058	0.021	0.02%
	(1.06)	(−1.15)	(0.74)	
5 (largest)	0.069***	−0.007	0.161	0.06%
	(6.12)	(−1.26)	(1.69)	

Panel B: Quintile by absolute size of trading imbalances

Absolute trading imbalance quintile	Intercept	δ_1	δ_2	*R*-square
1 (Smallest)	0.013	0.028	0.346**	0.05%
	(0.49)	(1.38)	(2.28)	
2	0.061*	−0.076	0.324**	0.14%
	(1.92)	(−1.24)	(2.90)	
3	0.074	−0.035	0.004	0.01%
	(1.13)	(−1.14)	(0.29)	
4	−0.042	0.006	0.021*	0.00%
	(−0.61)	(0.40)	(1.87)	
5 (Largest)	−0.101	0.018	0.173	0.02%
	(−2.51)	(1.38)	(0.90)	

Panel C: Quintile by sensitivity of stock returns to trading imbalances

Kyle's lambda quintile	Intercept	δ_1	δ_2	*R*-square
1 (Smallest)	0.028	0.011	−0.020**	0.01%
	(1.51)	(1.04)	(−2.66)	
2	−0.030	0.012	0.017***	0.00%
	(−0.98)	(0.90)	(4.11)	
3	0.014	−0.049	1.487	0.06%
	(0.14)	(−1.16)	(1.12)	
4	0.031	−0.012	0.078	0.00%
	(0.74)	(−0.70)	(0.87)	
5 (Largest)	−0.024	−0.012	0.444**	0.09%
	(−0.66)	(−0.20)	(2.90)	

Panel D: By sign of earnings surprises

Earnings surprise sign	Intercept	δ_1	δ_2	*R*-square
Negative	−0.809***	0.057*	0.135**	0.02%
	(−13.07)	(1.82)	(2.96)	
Positive	0.408***	−0.017***	0.038***	0.05%
	(18.48)	(−4.96)	(−12.03)	

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

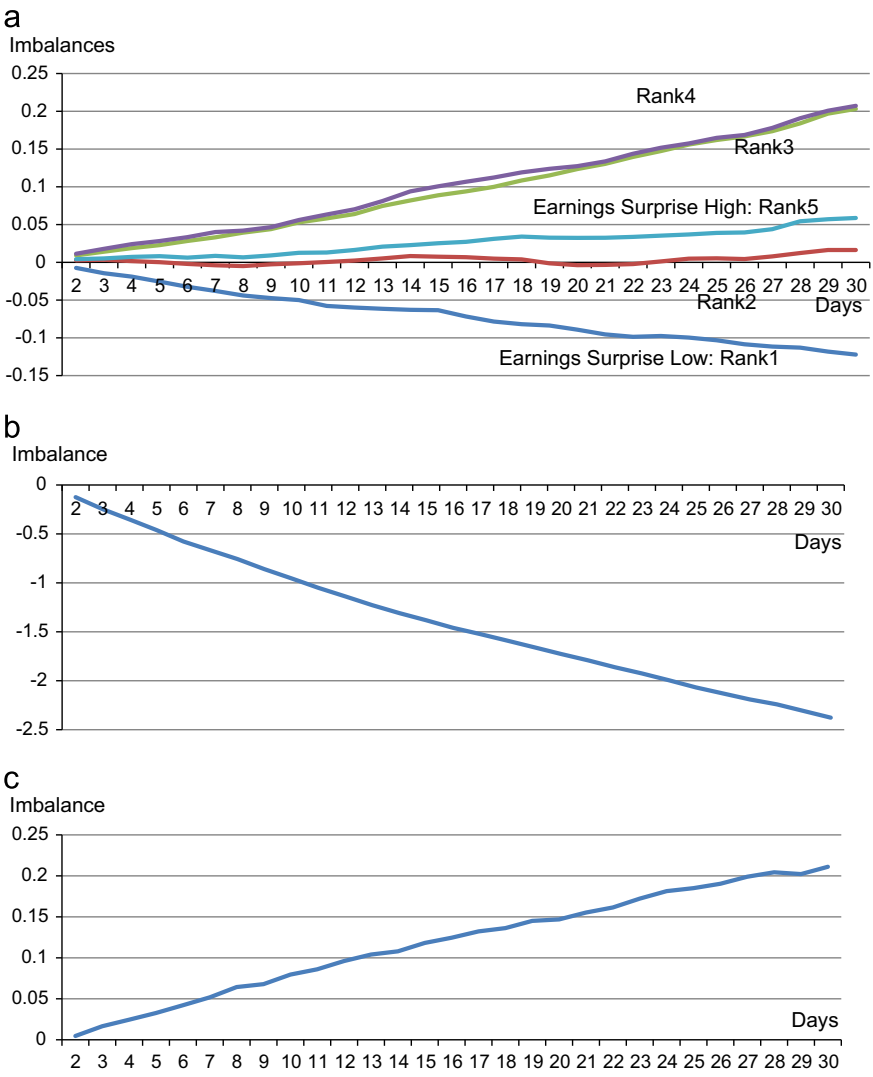

Fig. 7. (a) Cumulated excess trading imbalances after earnings announcements, (b) Cumulated excess trading imbalances after acquisition announcements and (c) Cumulated excess trading imbalances after SEO announcements.

announcements are determined more by autocorrelations than earnings information. Fig. 7b and c show imbalances after takeover announcements and SEO announcements. We observe reversals in these two events; imbalances become negative after takeover announcements and positive after SEO announcements. In none of the three cases do we find that imbalances trail past information.

9. Are stock returns related to subsequent news?

Information about the contents of an *upcoming* earnings announcement may become public as analysts conduct their research, and it will be reflected in current stock returns, consistent with efficient markets. Consequently, as posited in Hypothesis 2, we expect to reject the hypothesis that there is no association between earnings announcements and prior returns. The hypothesis is tested

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

Table 9
Cumulative trading imbalance and stock returns before earnings announcement.

We rank earnings surprises into deciles and report average 20-day cumulative trading imbalances and cumulative mid-quote stock returns by decile. The cumulative trading imbalances and stock returns are measured at five business days before the announcement date. We normalize the cumulative measures by subtracting daily average of trading imbalances or returns. We calculate the equal-weighted average by decile and standard errors of the mean are in parentheses. The standard error of the difference is in parentheses. *Significant differences in imbalances at the 1% level.

Earnings surprises rank	Cumulative trading imbalances	Cumulative stock returns
Low (most negative)	−0.205	−2.195%
	(0.026)	(0.188%)
2	−0.019	−1.215%
	(0.024)	(0.154%)
3	−0.068	−1.100%
	(0.024)	(0.159%)
4	−0.004	−1.175%
	(0.021)	(0.124%)
5	0.097	−0.746%
	(0.023)	(0.148%)
6	0.095	−0.363%
	(0.023)	(0.138%)
7	0.089	−0.398%
	(0.023)	(0.133%)
8	0.094	−0.059%
	(0.023)	(0.144%)
9	0.059	0.220%
	(0.024)	(0.159%)
High (most positive)	−0.075	0.360%
	(0.024)	(0.176%)
Difference between Highest and Lowest	0.130*	2.555%*
	(0.036)	(0.258%)

in Table 7 by the coefficient δ_2 on the lagged stock return. In Panel A, the coefficient is positive and significant in three of nine cases, while the explanatory power is low. This result indicates that returns have only a limited ability to anticipate earnings surprises.[14]

A direct comparison of the extent to which trading imbalances and stock returns anticipate earnings can be found in Table 9. Stocks are ranked by earnings surprise into ten categories. For each category, the 20-day cumulative prior imbalance and the 20-day cumulative prior return are calculated for the 20 days ending two days prior to the announcement.[15] The results in Table 9 look deceptively like Table 3. Recall, however, that the purpose of Table 3 is to assess whether earnings announcements cause stock price changes. They appear to do so, which implies that announcements convey information to the market. Alternatively, in Table 9 we assess the extent to which imbalances anticipate announcements. In particular, extreme positive announcements should be preceded by extreme positive imbalances, while extreme negative announcements should be preceded by extreme negative imbalances. However, this is not the case as noted in the top rank. The top rank (most positive announcements) is preceded by a negative imbalance. The largest trading imbalances are

[14] It is possible that the significance of the stock return is caused indirectly by an imbalance, as imbalance and stock return are correlated (Chordia and Subrahmanyam, 2004). In an unreported result, we filter out the effect of imbalances on stock returns by first regressing stock returns on contemporaneous imbalances. Then we test if the residual of stock returns, the unexplained portion of stock returns, are still significantly correlated with forthcoming earnings surprises. We find that many of the coefficients on the residuals are indeed significant. This result indicates that stock returns are related to subsequent events and the indirect effect of imbalance is marginal.

[15] We also performed the same test at different time periods, such as three, six, and ten days before the earnings announcement dates. The results are similar (weak correlation) and are not reported here.

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

Table 10
Trading imbalances and stock returns.
We use stock returns at five business days before a corporate announcement and estimate the following equation:

$$r_{i,t} = \alpha + \sum_{j=0}^{5} \gamma_j \, TI_{i,t-j} + \varepsilon_{i,q}, \tag{4}$$

r_{it} is the daily mid-quote stock return of stock i at day t and TI_{it} is the daily trading imbalance of stock i at day $t-j$. We use OLS estimation with heteroscedasticity corrected errors. T-values are in parentheses. *Coefficients significant at the 1% level.

	Panel A: Earnings announcements			Panel B: Acquisition announcements			Panel C: SEO announcements		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
$TI\ (t)$	0.025*	0.026*		0.020*	0.018*		0.026*	0.026*	
	(30.64)	(32.60)		(7.79)	(6.89)		(16.75)	(16.39)	
$TI\ (t-1)$		0.008*	0.012*		0.011*	0.013*		0.011*	0.014*
		(8.79)	(14.04)		(4.11)	(5.24)		(5.80)	(7.78)
$TI\ (t-2)$		−0.006*	−0.003*		−0.002	−0.001		−0.003	−0.001
		(−6.57)	(−3.72)		(−0.79)	(−0.32)		(−1.88)	(−0.48)
$TI\ (t-3)$		−0.004*	−0.002		−0.001	−0.001		−0.005	−0.002
		(−5.28)	(−2.23)		(−0.48)	(−0.37)		(−2.59)	(−1.09)
$TI\ (t-4)$		−0.002*	−0.001		−0.002	−0.001		−0.003	−0.002
		(−3.15)	(−0.84)		(−0.98)	(−0.48)		(−1.43)	(−0.85)
$TI\ (t-5)$		−0.004*	−0.002		0.004	0.005		−0.002	−0.000
		(−4.55)	(−2.21)		(1.48)	(1.90)		(−1.10)	(−0.22)
Adj. R^2	2.23%	2.63%	0.50%	2.70%	3.65%	1.56%	2.84%	3.36%	0.77%

observed in the middle earnings surprise ranks (5–6) instead of the highest ranks. Other than these abnormalities, there is some indication of a relationship between imbalances and earnings surprises, mostly for the negative surprises. Still, it can be difficult for investors to use negative imbalances as a predictor of negative surprises as the highest surprises also have negative imbalances. Stock returns, on the other hand, have a fairly monotonic relation with announcements.

10. Are stock returns related to imbalances?

The focus in this study is primarily on the link between information and trading imbalances, link (c) in Fig. 1. Thus far, we conclude that imbalances do not reflect the news. Researchers should be careful in assuming that imbalances are a reflection of private information. We now turn to an investigation of link (b) in Fig. 1, the correlation between stock returns and imbalances. We examine the extent to which imbalances are related to contemporaneous stock returns or anticipate returns. Hypothesis 3 addresses this issue.

Chordia and Subrahmanyam (2004) have studied the relation between returns and current and lagged imbalances. We use their model to address the same issue, but we focus on the days around the corporate announcements. Their model is:

$$r_{i,t} = \alpha + \sum_{j=0}^{5} \gamma_j \, TI_{i,t-j} + \varepsilon_{i,q}, \tag{4}$$

where r_{it} is the daily mid-quote stock return of stock i at day t and TI_{it} is the daily trading imbalance of stock i on the same day t and on lagged days $t-j$.

The difference between our test and the test in Chordia and Subrahmanyam (2004) is the sample. They use all of the daily stock return observations from 1988 to 1998. They determine that returns and imbalances are contemporaneously correlated. We select stock returns before major corporate announcements from 1993 to 2010 and test whether returns and imbalances are correlated prior to

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

the announcement dates. Is the relation between imbalances and returns different if there is an important announcement?

We select five business days before the corporate announcements and estimate Eq. (2). Thus, our left-hand side variable is the mid-quote stock return at that date.[16] Table 10 shows that trading imbalances are significantly correlated with contemporaneous returns. This correlation may reflect the direct effect of trading pressures or the information conveyed by the imbalances. However, since the imbalances are not correlated with subsequent information, the contemporaneous correlation probably reflects trading pressures, not private information. As noted earlier, imbalances do not anticipate information; rather, they occur with the information. The significant association between trading imbalances and contemporaneous returns is consistent with the results of Chordia and Subrahmanyam (2004). One lag imbalances also have a positive, but much weaker correlation with returns. From the regression models that do not include contemporaneous imbalances, we find the first lag of imbalance predicts stock returns. We verify the prediction power is limited to the first lag – one day. Two lag imbalances tend to be negative indicating a tendency for reversals, which is typical of trading pressures.

In sum, we find that trading imbalances and returns are correlated contemporaneously, and imbalances have limited predictive power for the next day's returns. This association may reflect a common reaction to future news; however, if that were the case, the imbalances would also be correlated with the subsequent news. Since they are not, the contemporaneous correlation between imbalances and returns must reflect trading pressures, not a common reaction to anticipated news.

11. Conclusions

Empirical studies of asset prices tend to assume that a price change associated with an imbalance in trading reflects information. This view dates back to the seminal theoretical work of Kyle (1985) where the informed trader strategically trades to unwind inventory and, in the process, pushes prices and conveys some of the information. Surprisingly, no one has directly tested whether an imbalance in trading reflects information or whether the imbalance is simply a random event.

In this study, the relation between trading imbalances and subsequent information is examined using daily trading imbalances. We use three major corporate announcements as the information source: earnings announcements, mergers, and SEOs. The earnings are newsworthy in that prices respond at the time of the earnings announcement. However, we find that prior trading imbalances are not significantly related to forthcoming news measured as unexpected earnings or as the value of the earnings surprise. While an earnings announcement is a scheduled event, we also examine some of the unexpected announcements, mergers, and SEOs. Again, while these are newsworthy events, we find little evidence that imbalances reflect these announcements. Past returns provide some information about upcoming news, as would be expected in a market in which news is produced on an on-going basis and is quickly discounted in the price. Yet there is not enough evidence that imbalance signals additional private information beyond the public information reflected in the price.

We find that there is a positive correlation between trading imbalances and contemporaneous stock returns. The correlation is contemporaneous and it does not provide information about upcoming news. It more likely reflects the imbalances resulting from trading pressures that also temporarily move prices.

Overall, we conclude that the link from information to imbalances to prices is more complex than previously thought. Our work suggests that observed daily trading imbalances contain less private information than is usually assumed by researchers.

[16] We used other estimation points between three to ten business days prior to the announcements and found little change in the results. A pooled regression that uses multiple days' observations also yields similar results.

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

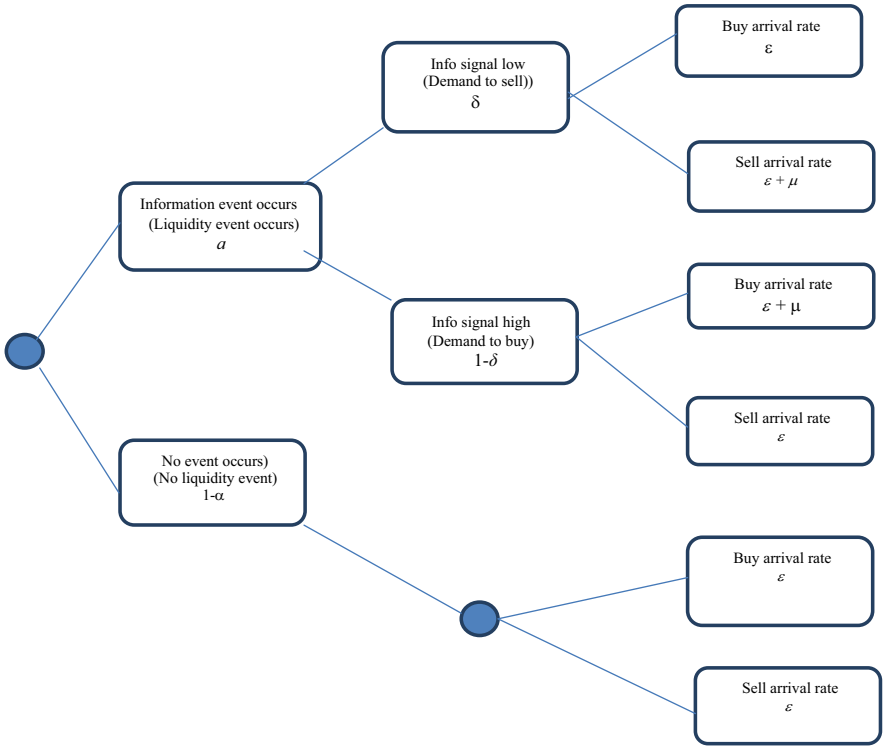

Fig. A1. Tree diagram of the trading process based on private information (not in parentheses) and on liquidity shocks (in parentheses).

Appendix A

See Fig. A1.

Appendix B. The construction of trading imbalance data

1. Criteria for stock selection are:
   - Data source comes from Trade and Quote (TAQ) data.
   - Data period is from January 1993 to December 2010.
   - We exclude certificates, ADRs, shares of beneficial interest, units, Americus Trust components, closed-end funds, preferred stocks, and REITs from the dataset.
   - We delete the stock that is from the sample year if the price at any month-end during the year was greater than $999.
   - We eliminate non-synchronous trading issues by marking the stock return as missing if there was no trade on today or the previous day.
2. When constructing the trading imbalance variable, we only use quotes and trades such that:
   - Quotes and trades are in regular market trading times (from 9:30 to 16:00).
   - There are no special settlement conditions.
   - All bid-ask spreads are positive.
3. Method to calculate trading imbalance is (Lee and Ready, 1992 method):
   - A trade is buyer (seller) initiated if it is closer to the ask (bid) of the prevailing quote.
   - Prevailing quote should be at least five seconds old.

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003

If the trade is at the midpoint of the quote, the trade is buyer (seller) initiated if the prior stock price change was positive (negative).

References

Andrade, S., Chang, C., Seasholes, M.S., 2008. Trading imbalances, predictable reversals, and cross-stock effects. J. Financ. Econ. 88, 406–423.
Atkas, N., de Bodt, E., Declerck, F., Van Oppens, H., 2007. The PIN anomaly around M&A announcements. J. Financ. Mark. 10, 169–191.
Bernard, V.L., Thomas, J.K., 1990. Evidence that stock prices do not fully reflect the implications of current earnings for future earnings. J. Acc. Econ. 13, 305–340.
Campbell, J.Y., Ramadorai, T., Schwartz, A., 2009. Caught on tape: institutional trading, stock returns, and earnings announcements. J. Financ. Econ. 92, 66–91.
Chordia, T., Roll, R., Subrahmanyam, A., 2002. Order imbalance, liquidity and market returns. J. Financ. Econ. 65, 111–130.
Chordia, T., Subrahmanyam, A., 2004. Order imbalance and individual stock returns: theory and evidence. J. Financ. Econ. 72, 485–518.
Collin-Dufresne, P., Fos, V., 2012. Do prices reveal the presence of informed trading? Working paper. University of Illinois at Urbana-Champaign.
Duarte, J., Young, L., 2009. Why is PIN priced? J. Financ. Econ. 91 119–138.
Easley, D., Engle, R.F., O'Hara, M., Wu, L., 2008. Time-varying arrival rates of informed and uninformed trades. J. Financ. Econ. 6 (2), 171–208.
Easley, D., Kiefer, N.M., O'Hara, M., 1997. One day in the life of a very common stock. Rev. Financ. Stud. 10 (3), 805–835.
Easley, D., Kiefer, N.M., O'Hara, M., Paperman, J., 1996. Liquidity, information, and infrequently traded stocks. J. Financ. 51, 1405–1436.
Fleming, M.J., Remolona, E.M., 1999. Price formation and liquidity in the U.S. treasury market: The response to public information. J. Financ. 54, 1901–1915.
Huang, R., Stoll, H., 1994. Market microstructure and stock return predictions. Rev. Financ. Stud. 7 (1), 179–213.
Inci, A.C., Seyhun, H.N., 2012. How do quotes and prices evolve around isolated informed trades? J. Econ. Financ. 36 499–519.
Kaniel, R., Liu, S., Saar, G., Titman, S., 2012. Individual investor trading and return patterns around earnings announcements. J. Financ. 67, 639–680.
Kraus, A., Stoll, H.R., 1972. Price impacts of block trading on the New York Stock Exchange. J. Financ. 27, 569–588.
Kyle, A.S., 1985. Continuous auctions and insider trading. Econometrica 53, 1335–1355.
Lee, C.M.C., Ready, M.J., 1992. Inferring trade direction from intraday data. J. Financ. 46, 733–747.
Lin, J.C., Sanger, G., Booth, G.G., 1995. Trade size and components of the bid-ask spread. Rev. Financ. Stud. 8, 1153–1183.
Lindley, D.V., 1957. A statistical paradox. Biometrika 44, 187–192.
Madhavan, A., Richardson, M., Roomans, M., 1997. Why do security prices change? A transaction-level analysis of NYSE stocks. Rev. Financ. Stud. 10, 1035–1064.
Mendenhall, R.R., 2004. Arbitrage risk and post-earnings-announcement drift. J. Bus. 77, 875–894.
Petersen, M.A., 2009. Estimating standard errors in finance panel data sets: Comparing approaches. Rev. Financ. Stud. 22, 435–480.
Stoll, H., 2000. Friction. J. Financ. 55, 1479–1514.

Please cite this article as: Kim, S.T., Stoll, H.R., Are trading imbalances indicative of private information?. Journal of Financial Markets (2014), http://dx.doi.org/10.1016/j.finmar.2014.03.003