Asymmetric post earnings announcement drift and order flow imbalance: The impact on stock market returns

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Abstract

We conduct an event study around the earnings announcement to examine the asymmetric post earnings announcement drift, and its relationship with the bid-ask bias, order follow imbalance on post earnings announcement period for UK stock market from 2000-2021. The earnings drift is significantly asymmetric in the post earnings announcement period, stocks with good news have less drift, and it (at least) is partly due to the order flow imbalance during the event period. The earnings announcement attracts more sell than buy orders, and an overall negative reaction in the market. The difference between transaction price return and quote price returns shows that the bid-ask bias is also a possible explanation of post earnings announcement drift. Our results are robust across different estimations and robustness tests.

JEL code: G10, G14

Keywords:
Post Earnings Announcement Drift; Order Flow imbalance; Bid-ask bias; Earnings Surprises; Market Efficiency.

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1. Introduction

Stock markets' anomalies around the earnings announcement have long been examined in the literature, e.g.: overreaction and long-term price reversals (Lo and Coggins, 2006), buy and sell orders volatility (Chordia et al., 2009), and return drift anomaly (Park et al., 2014). Even many anomalies can be explained by some form of liquidity and/or risk premium, others claim to violate the efficient market hypothesis (EMH) in its semi-strong form. EMH believes that investors should trade according to the information, buy (sell) stocks associated with good (bad) news. However, post-earnings-announcement-drift (Hereafter, PEAD), also referred to as the standardized unexpected earnings effect, reveals that stock prices continue to move in the direction of the earnings, suggesting that the stock market is not completely efficient in processing the publicly available information. According to "individual investor distraction hypothesis" which is proposed by Hirshleifer et al. (2009), earnings announcements convey new information to the market which is actively seeked by investors. However, the investors may differ in the resources of news as well as in the information acquisition and processing skills. Also, a large amount of information from the market distracts the investors, their trading behavior during the post-announcement period impedes a full price response to the news, leading to the under-reaction and PEAD anomaly. Consequently, the different response to the information causes the different investor behavior in the market.

On the other hand, Savor (2012) finds that stock events driven by information are followed by PEAD, whereas the anomalies can also be attributed to the bid-ask bounce effect. The bid-ask bounce is a result of trades taking place at the bid or ask quote as opposed to the bid-ask midpoint which would be the case if order flow was balanced (Gosnell et al., 1996). Lease et al. (1991) find that a company announcement can result in a movement of closing price towards either the ask (a majority of buy orders) or the bid quote (a predominance of sell orders), and it can be measured by the order flow ratio. Chordia et al. (2019) note that the two components of bid-ask spread, adverse selection costs and inventory holding costs increase in line with the variability of order flow imbalance. Also, the volatility of order flow is a proxy for costs of information asymmetry. On the other hand, Lee et al. (1993) find that bid-ask spreads and information asymmetry increase prior to earnings announcements, the widen bid-ask spread increasing the possibility of the bid-ask bounce effect around the announcement. In general, prior studies suggest that investors widen bid-ask spreads, reduce order size and postpone trading behavior around the earnings announcements. Therefore, we hypothesize that the anomaly around the earnings announcement is not only because of the drift effect, but also caused by the order flow imbalance between buy and sell orders.

In our study, we aim to answer the following questions: First, does the earnings announcement cause the order flow imbalance and PEAD anomaly together for firms in the post earnings announcement period? Second, is the PEAD anomaly asymmetric around the earnings announcement, and does it

relate with the buy or sell pressure around the good or bad earnings news? According to Frino et al. (2017) and many other studies, bounce between bid and ask quote can be purged by replacing transaction price-based returns by mid-point-based returns, therefore, it provides a unique environment for examining the PEAD anomaly around the event separately. Our study uses an event study methodology around the earnings announcement period. For each sample firm, we have the earnings announcement report, the quoted price, the transaction price and other firm-level information, which allow us to establish a comprehensive analysis for the stock behavior. Using a sample of 17304 firm quarters over 2000-2021, we find evidence that, firstly, drift anomaly is significant during the post earnings announcement period, along with the order flow imbalance and bid-ask bias error. When we purged the bid-ask bias during the period, we find that the PEAD anomalies become more pronounced, the stock volatility has a more obvious effects on the PEAD return. Order flow disruption causes a bias in the calculation of returns around the company event announcement. Secondly, the asymmetric drift between the good and bad news group is present for all event windows, stocks with good news have less drift, investors tend to underreact to good news and over-react to bad news, and the order flow imbalance of bad news stocks will reverse during the short term. Earnings announcements attract more sell orders than buy orders, relating with the overall negative reaction around the announcement.

To the best of our knowledge, while research on the order flow imbalance and PEAD does exist, no previous study has attempted to examine them collectively. Lee (1992) analyses order imbalance around the earnings announcements. Park et al. (2014) examine the relation between net buying and earnings announcement. Bissoondoyal-Bheenick et al. (2019) examine the order flow imbalance around the good and bad news. But none of them related the order flow imbalance with the drift effect around the earnings news. Hirshleifer and Teoh (2003), Louis and Sun (2011) and Savor (2012) relate the PEAD with investors' underreaction. Ng et al. (2008) analyse PEAD and the transaction costs. However, all these studies did not measure the drift with the order flow imbalance and did not examine the drift effect for positive news and negative news separately. It is not clear whether the order flow imbalance and PEAD anomaly are correlated or whether similar results hold for FTSE 350 firms.

Also, we provide a new insight into investor behavior around the different types of news by dividing earnings announcements into positive and negative events. Positive earnings surprise in some previous studies are treated as a similar event to negative surprises. However, the magnitude of drift may differ with the different direction of surprises. Kothari et al. (2009) find that the negative stock price reaction to bad news is greater than the positive stock price reaction to good news. Park et al. (2014) reveal that the magnitude of information asymmetry around the negative earnings shocks is much larger than that around positive news. However, these studies just focus on the cumulative drift returns and ignore the order flow imbalance around the event. Hendershott et al. (2015) indicate that buy-orders are much

more than sell orders prior to the announcement of good news and bad news attracts more sell-orders before the announcement. Chan (2003) examines the drift after different types of news and attempts to relate it with the bid-ask bounce. He finds that the bad public news is associated with the negative return drift whereas good news usually has less drift, resulting in investors overreaction to spurious price moves. However, his study focuses on all public news rather than earnings announcements and did not relate with buy and sell pressure around the announcement. Therefore, we hypothesize the asymmetric effect between positive and negative news are not only related with the asymmetric PEAD, but also associated with the imbalance between buy and sell orders.

Another contribution of our study is our research is based on the UK market, London Stock Exchange (LSE) provides the trade classification by their system, so we do not need to use the trade assignment algorithm to identify the buy and sell orders. Most of the previous studies rely on Lee and Ready (1991) method to do the classification. However, Odders-White (2000) demonstrates that the Lee and Ready classification can be biased. The quote at the time of trade execution may not be that trade's associated quote. Moreover, trades at the midpoint between the bid and ask are not classifiable. Trades within the spread, small trades and trades in large or frequently traded stocks are more likely to be misclassified. In the research of Theissen (2001), 25.1% of the observations in the study cannot be unambiguously classified as buyer- or seller-initiated. Misclassification of trades may systematically bias the results, especially for the empirical microstructure research. Our research avoids these problems by the unique classification system provided by LSE.

The remainder paper is organized as follows. Section 2 presents the hypothesis development and review of prior research. Section 3 discusses the dataset. Section 4 describes the methodological approach used to undertake the econometric analysis. Section 5 reports the empirical analysis, Section 6 shows several robustness tests and the conclusions outlined at Section 7.

2. Literature Review and Hypotheses development

2.1 Asymmetric PEAD anomaly around the earnings announcement

For a number of stock markets, many studies confirmed the existence of PEAD by different methodologies. Ball and Brown (1968) is the first study to find that stock prices continue to drift the direction of earnings surprises for several months after the earnings are announced. Using a sample from 1987 to 2008 in the U.S. market, Cao and Narayanamoorthy (2011) show that the persistence of the earnings surprise is equally important along with market reactions to the magnitude of the earnings surprise. By forming sample stocks into quintile based on unexpected earnings (UE) which measured the magnitude of PEAD, Dargenidou et al. (2018) find that the gap between top and bottom UE group is a significant 3.4% during the long term after the earnings announcement.

Seeking to find the reason behind the PEAD, subsequent studies explain the anomaly in the following ways. Bartov (1992) based on data from 1979-1987 in the U.S. market, find a market-inefficiency explanation for PEAD anomalies. Narayanamoorthy (2006) simply believes that PEAD is due to the accounting disclosure error or investors' misestimation of expected returns. Using bid-ask spread to reflect the information environment of market, Liang (2003) reports that the reliability of the earnings disclosure and investors' overconfidence about their private information are two sources that lead to drift, PEAD is associated with the slow reaction to the information contained in earnings announcements. Louis and Sun (2011) find that PEAD is mainly due to investors underreacting to the news because they do not fully understand the information which is conveyed by earnings announcements, or firms incorporate less transparent news in earnings reports. Also, from the view of the under-reaction, Hirshleifer and Teoh (2003) believe that more information is competing for investors' attention than they can process, investors are inattentive to earnings news then leading to the under-reaction. Frazzini (2006) suggests that the underreaction to news are partly induced by the disposition effect of investors—the tendency to ride losses and gains.

Savor (2012) relates the PEAD anomaly and underreaction with the investors' behavioral biases, which is measured by investor sentiment. Baker and Wurgler (2006) define investor sentiment as an investor's degree of optimism or pessimism regarding financial markets. Traditional financial theory rejects the effect of sentiment because it assumes that rational investors dominate the market, the price adjustment to new information is always rational and instantaneous. However, recent behavioral finance studies (e.g.: Seok et al., 2019) provide evidence to confirm that earnings announcements can affect investors' moods and sentiments, then causes prices to diverge from the fundamental values. If positive (negative) earnings surprises induce optimistic (pessimistic) beliefs for stocks, the investor sentiment around the earnings announcement should be related to the price reactions to the news. Livnat and Petrovits (2009) show that investors maybe not fully, but correctly updating their expectation when they receive opposite news. The subsequent stock returns are relatively high following the low investor sentiment time, suggesting that stocks are underpriced during the period. On the other hand, Mian and Sankaraguruswamy (2012) find that the stock price sensitivity to good news is greater during high sentiment periods, the effect of sentiment persists and influences the drift in the subsequent 60 days after the announcement. Also, Seok et al. (2019) find that the stock price reaction to positive earnings surprises is significantly greater for firms with high sentiment.

Many studies focus on the asymmetric drift effect between the positive and negative news. Chan (2003) discovers that stocks with negative news display a negative drift for up to one year, much longer than the stocks with good news, it means the prices are slow to reflect bad public announcements. On the other hand, Eom et al. (2019) reveal that in the Korean stock market, drift is much stronger and more persistent for positive earnings surprise, especially when individuals are net

sellers following the announcement. Dargenidou et al. (2018) reveal that individual investors trade in a news-contrarian manner, buying after negative earnings shocks and selling after positive earnings surprise, it potentially slows the adjustment of stock prices to the news and mitigate the PEAD. Kothari et al. (2009) point out that the firm voluntarily publicise only good information whereas withhold other news for differentiating themselves from firms with bad news. Graham et al. (2005) find out that the bad-news firms tend to delay in releasing bad news in order to further interpret the information. These studies are related with Brown et al. (2009), who examine that in the U.S. market, there is a long-lasting information asymmetry, that decreases following a positive earnings surprises whereas increases following the negative earnings shocks. Therefore, we predict the following:
H1: the PEAD anomaly exists in the post earnings announcement period, and the drift is asymmetric between positive and negative news in the UK market.

2.2 Order flow and PEAD anomaly

The bid-ask bias and order flow imbalance are also a possible reason for return anomalies during the post announcement period. Imbalance between buy and sell orders affect liquidity strongly, signal private information around the news, and move stock prices permanently (Hasbrouck, 1991). Lease et al. (1991) discover that the order flow imbalance causes the stock return volatility around the news and related with buying or selling pressure. Brown et al. (1997) believe that the temporal order flow imbalance around the event announcement is due to the informed traders attempt to pre-empt good or bad news, then further orders react accordingly. Han and Lesmond (2011) argue that the price movement following the news announcement is not a “true” price movement, the return gain or loss is spurious as it will reverse as transactions resume back to the mid-point price, then increases the volatility of stock returns. Lo and Coggins (2006) maintain that the degree of return reversal is positively related to the level of order flow imbalance. Levi and Zhang (2015) find that more liquidity sales than liquidity purchases during the preannouncement period, and liquidity sales lead to positive returns initially, then followed by a return reversal, reveals that investors postpone buying stocks until the post earnings announcement period.

There are two kinds of corporate information releases in the market, the expected announcements, which have scheduled time to release information (e.g.: earnings announcements) and the unexpected announcements (e.g.: acquisition announcements) which is unscheduled. Chae (2005) points out whether an announcement is scheduled or not affects the trading activities, when the timing of information release is available, investors know that there is a large amount of information to be released on a specific date and they tend to postpone their trading behavior until the information is released as well as the information asymmetry is alleviated. Then, the reduction of trades before expected announcements is often followed by a significant increase in trading volumes during and

after the earnings announcements. Similarity, recent research by Chen (2023) finds that investors hesitate to take action around the earnings news because diversely informed beliefs may hinder the absorption of earnings news, it is positively associated with the PEAD and delays market response to corporate announcements.

Though investors reduce both their sales and purchases of stocks before earnings announcements, such reduction in trades may not be symmetric. Chan and Lakonishok (1993) show that for liquidity traders in the market, sell orders contain more pressure than buy orders. Thus, liquidity traders have less willingness and flexibility to reduce their sales than to reduce their purchases. Also, Campbell et al. (2009) observe that investors pay more transaction costs and have less flexibility when selling compared with purchasing. Keim and Madhavan (1995) find that the duration time for buy orders is significantly longer than that of sell orders, investors are more reluctant to buy. On the contrast, Levi and Zhang (2015) provide evidence that investors with passive investment strategies reduce more in purchasing, which results in a net selling phenomenon around the earnings announcements.

Moreover, Gosnell et al. (1996) reveal that order flow is enormously imbalanced around the different types of news, a dominance of sell (buy) orders immediately after the bad (good) news announcement, closing-price returns should have a higher volatility than that of quoted price-based returns. If closing price one day before the announcement executed at the bid(ask) price while closing prices after the announcement executed at the ask(bid) price, the magnitude of bid-ask bias would be much higher. Lee (1992) finds that the duration and adjustment between the buy and sell imbalance after the earnings news shows how quickly the market adapts to the new equilibrium price, trades respond to positive news by a period of intense buying, whereas respond to negative news by intense selling. Conrad et al. (2002) show that good earnings news is considered to be more informative than bad news. Therefore, investors may update their beliefs only in the case of positive news. Moreover, Kim and Stoll (2014) uncover the evidence suggesting that the relation between order imbalance and earnings surprises mostly for the negative surprises, and it signal the private information. Positive news will cause informed traders to buy stocks then increase the price, while negative news will encourage them to sell stocks and lower the price. Accordingly, we make the following hypothesis:

H2: the earnings announcements cause the order flow imbalance for FTSE350 firms, and the asymmetric effect between buy and sell orders affect the drift after the positive and negative news.

3. Data

3.1 Data sources and variables

Our sample dataset records the firms listed on the FTSE350 index between 1 January 2000 and 31 December 2021. Financial, utility companies and closed-end mutual funds are excluded. The FTSE350 consists of the largest 350 firms listed on the London Stock Exchange with respect to market capitalization, represents around 90% of the entire trading volume on London Stock Exchange, therefore, it provides a comprehensive view of the UK market. The quarterly earnings announcement dates and earnings reports data are collected from Thomas Reuter Eikon. The implication of these criteria yield, that 206 firms have sufficient data to enable us to perform economics analysis. In total, there are 17404 earnings announcements over 2000-2021.

Bhushan (1994) believes that the drift is inversely related to both the share price and trading volume, the share price is a proxy for the inverse of direct costs of trading whereas trading volume is a proxy of indirect transaction costs. Therefore, we obtain both stock price and trading volume variables in our analysis. Additionally, we obtain the firm size (number of shares traded multiplied by the share price) as one of the firm-level variables; We also collect the standard deviation of stock returns as a proxy of stock volatility, bid and ask price in order to compute the bid-ask spread and order flow ratio.

3.2 Earnings Announcement Timings

Jennings and Starks (1986), Truong and Corrado (2014) and many studies believe that the firms may release news strategically. For hiding bad news, firms strategically announce their negative earnings information when the market attention is lower, for example, after market closes and on busy reporting days. Previous studies have speculated three specific periods where market attention differs: on Fridays versus Mondays through Thursdays (DellaVigna and Pollet, 2009); before versus after the close of regular trading hours (deHaan et al., 2015); and on “slow” versus “busy” news days (Hirshleifer et al., 2009). Since many analysts have already left for the weekend, Michaely et al. (2016) believe that the worst earnings news is announced on Friday evening, in order to reduce interaction with investors. Both good and bad news on Friday evening is followed by the largest PEAD. Hirshleifer et al. (2009) provide the evidence to show that greater PEAD is on days with numerous earning announcements. Patell and Wolfson (1982) speculate that earnings announcements that occur in the evening might receive less attention than similar news that is released earlier in the day. On the other hand, they also note that the opposite could be true: the evening earnings announcements could receive greater attention since more time is allowed for news spreading and interpretation before trading begins the following day. Doyle and Magilke (2009) also find no

evidence that managers switch announcements of bad earnings news to Friday or evening. daHaan et al. (2015) provide the evidence to show that just 7.6% of all earnings announcements happen on Friday, and it is actually no different in terms of attention level on Fridays as compared to the rest of weekdays.

Figure 1 provides descriptive information on intra-day and intra-week distributions of earnings announcements[2]. As depicted in Panel A, the timing of earnings announcements has changed dramatically in recent years, almost no firms announce earnings during market hours. For example, in 2021, 49.6% of announcements happen before U.K market trading hours, while 43.7% happen after trading hours. Overall, just 6.7% of announcements happen during trading hours. Panel B shows that the frequency of announcements per working day rises from 18.9% on Mondays to 25.1% on Wednesday and 26.6% on Thursdays, followed by a dramatically decline to just 11.80% on Fridays. To some extent, the relatively few earnings news on Friday lead to each individual announcement receiving more attention than announcements on other days of the week. Our results provide the evidence to support that the previous market attention theory does not have influence on the trading patterns of investors, the firms do not change their announcement timing according to "weekday effect" , or "busy day effect". In today's information-rich environment, the majority of stock trading is driven by computer algorithms that are likely to be unaffected by the times of announcement. Also, since earnings season is highly anticipated and the announcing dates are often known in advance, market participants can pay adequate attention to numerous earnings news by arranging their trading schedules previously.

[INSERT FIGURE 1 HERE]

4. Methodology

4.1 Earnings surprise

For the earnings surprise measurement, we choose the earnings-announcement-based model in our study. Following Ng et al. (2008) and many other studies, we use the standardized unexpected earnings (*UE*) to capture the earnings surprise, defined as changes in quarterly earnings scaled by the market value of stock *i*:

$$UE_{i,q} = \frac{E_{i,t} - Ei,q-4}{MV_{i,q-4}} \quad (1)$$

[2] Figure 1 requires that the sample have a time stamp from our database, that reducing the sample to 16338 observations.

Where $E_{i,t}$ is the most recent quarterly earnings for stock *i* at time *t*, $E_{i,q-4}$ is the quarterly earnings four quarters before for stock *i* at time *t* , and $MV_{i,q-4}$ is the market capitalization four quarters earlier for stock *i* at time *t*. Some studies (e.g.: Chordia et al., 2009) apply the earnings-based measurement which scale the changes between most the recent quarterly earnings and previous four quarters by the standard deviation of prior unexpected earnings. For obtaining the largest sample in our study, we follow Ng et al. (2008), using market value to scale the changes of earnings. Based on the distribution of the earnings surprises, the sample firms are assigned into decile portfolios with 0 representing the smallest decile and 1 means the largest decile.

4.2 Order flow ratio

The database of LSE allows us to identify the exact trading direction without referring to any identification algorithms. The location of trading prices within the bid-ask spread can be classified as: A. Above and at the ask price. B. Between the ask and midpoint price. C. Between the midpoint price and the bid price. D. At and below the bid price. We follow Lease et al. (1991), by computing the within-spread location of the closing price for each firms' stock i for each event day as:

$$\text{Order flow ratio} = \frac{(\text{ask} - \text{price})}{(\text{ask} - \text{bid})} \quad (2)$$

We assume that buyers purchase at the ask price and sellers sell at the bid price. The positive earnings surprises attract more buy orders whereas the negative shocks are likely to cause more sell orders. The nearer order flow ratio is to 1, the more likely the transaction price is at the bid quote, indicating the selling pressure. While the closer this ratio is to 0 the greater the likelihood of the trade occurring at the ask, indicating the buying pressure.

4.3 PEAD return around the earnings announcement

As previous research suggests that the magnitude of PEAD varies cross-sectionally with several factors, following most of classic PEAD papers (e.g.: Bhushan, 1994) and order flow papers (e.g.: Lease et al., 1991), we apply the market adjusted model for our sample:

$$AR_{i,t} = R_{i,t} - R_{v,t} \quad (3)$$

Where $AR_{i,t}$ is the abnormal return earned by stock *i* at time *t*. $R_{i,t}$ is the return on stock *i* at time *t*, and $R_{v,t}$ is the value-weighted market index return at time *t*. As a proxy for the market's return, we use the FTSE index returns for the sample period. The announcement date (day *0*) is the day of the earnings announcement.

We compute the Cumulative Abnormal Return (*CAR*) of the event window by estimating the following equation:

$$CAR_{i,t(-q,+q)}=\sum_{t=q}^{s} \mathrm{AR}_{i,t} \quad (4)$$

Where *q* represents the different time periods during the event window. The standard *t-test* is used to test whether the $AR_{i,t}$, $CAR_{i,t}$, differ significantly from zero.

For the short run PEAD anomaly measurement, we examine ARs for the three-day period [-1, +1], and five-day period [-2, +2] around the announcement day (according to Lease et al., 1991, the two-day event window is the standard period of event study since ambiguity about the time of event day occurs). For long-term effect, we compute the ARs from the first day after the earnings announcement to the 60 days after the announcement [+1, +60]. We skip the event day (day 0) from the analysis to avoid any possible noisy information (Ng et al., 2008). The event window ends at 60 days after earnings announcement is according to Hirshleifer et al. (2009), who demonstrate that the abnormal returns are predictable up to 60 trading days after quarterly earnings announcements.

Transaction price-based return might be biased by the bid-ask bounce effect, because it implicitly assumes that trades occur with equal probability at the bid or ask price. Hasbrouck (1991) indicates that the quote midpoint can be regarded as a fairly unbiased estimator of stock's true value. Therefore, following Hasbrouck (1991), Lease et al. (1991) and many other studies, for mitigating the influence of shifts between the bid or the ask quote, we measure stock returns using both the midpoints price and closing price. We define R^m as returns calculated using midpoint price. R contains pricing errors due to the bid-ask bias, R^m however is constructed using only midpoint price, suggesting that it is robust to bid-ask spread errors. We calculate the $AR^m_{i,t}$, $CAR^m_{\mathrm{i,t}}$ based on midpoint price as well using the following formula:

$$\mathrm{AR}^{\mathrm{m}}_{i,t}=\mathrm{R}^{\mathrm{m}}_{i,t}-\mathrm{R}_{v,t} \quad (5)$$

$$CAR^{m}_{\mathrm{i,t(-q,+q)}}=\sum_{t=q}^{s} AR^{m}_{i,t} \quad (6)$$

4.4 PEAD and order flow ratios

Firstly, we are interested in the relationship between order flow imbalance and PEAD returns, therefore, we estimate the regression analyses as equation (7):

$$PEAD_{i,t}=\beta_0+\beta_1 OF_{i,t}+\beta_2 Vol_{i,t}+\beta_3 Size_{i,t}+\beta_4 StdDev_{i,t}+\beta_5 Price_{i,t}+\beta_6 Spread_{i,t}+\varepsilon_t \quad (7)$$

Next, following Ng et al. (2008) and many prior research, we use the ordinary least squares method to obtain the cross-sectional variables of both closing and midpoint PEAD returns

during the earnings announcement period. Specifically, the regression takes the following forms:

$$PEAD_{i,t}=\beta_0+\beta_1 UE_{i,t}+\beta_2 UE^{*}OF_{i,t}+\beta_3\, UE^{*}Vol_{i,t}+\beta_4\, UE^{*}Size_{i,t}+\beta_5\, UE^{*}StdDev_{i,t}+\beta_6\, UE^{*}Price_{i,t}+\beta_7\, UE^{*}Spread_{i,t}+\varepsilon_{t.} \quad (8)$$

$$PEAD^{m}{}_{i}=\beta_0+\beta_1 UE_{i,t}+\beta_2\, UE^{*}OF_{i,t}+\beta_3\, UE^{*}Vol_{i,t}+\beta_4\, UE^{*}Size_{i,t}+\beta_5\, UE^{*}StdDev_{i,t}+\beta_6\, UE^{*}Price_{i,t}+\beta_7\, UE^{*}Spread_{i,t}+\varepsilon_{t.} \quad (9)$$

The subscript *i* represents the 17304 earnings announcements of sample firms in our study. The dependent variables, $PEAD_{i,t}$ and $PEAD^{m}{}_{i,t}$ denotes (1). *PEAD3(5)* which is the *CAR* from one(two) day before the announcement to one(two) day after the announcement. (2). *PEAD(+1,+10), PEAD(+1,+30) and PEAD(+1,+60)* indicates that the *CARs* from one day after the earnings announcement to 10, 30 and 60 days after the announcement day, for stock *i*. We capture both the transaction-price-based return (*PEAD*) and the mid-point-price based return ($PEAD^{m}$). Independent variables including $UE_{i,t}$, defined as the earnings surprises measured by equation (1). $UE^{*}OF_{i,t}$ refers to the order flow ratio measured by equation (2) for stock *i* at time *t*. $UE^{*}Vol_{i,t}$ is the natural logarithm of the average daily volume of trading in stock *i* at time *t*. $UE^{*}Size_{i,t}$ is the natural logarithm of the market capitalization of firm *i* at time *t*. $UE^{*}StdDev_{i,t}$ is the natural logarithm of standard deviation of the stock price, which captures the volatility in the stock return for stock *i* at time *t*. $UE^{*}Price_{i,t}$ is the natural logarithm daily average share price of stock *i* at time *t*. $UE^{*}Spread_{i,t}$ is the bid-ask spread of stock *i* at time *t*. *UE** means that the variables are sorted into deciles within each calendar quarter and rescale the data to range from 0 to 1 in order to reducing the effect of outliers. We predict that $UE^{*}OF_{i,t}$ should have a negative relationship with PEAD.

5. Empirical Results

5.1 Descriptive statistical based on UE deciles

Panel A of Table 1 presents the firm characteristics for UE-sorted decile portfolios of all sample firms. On average, the firm size is £7210.7 million and trading volume is 4936 million shares. The average bid-ask spread of sample firms is 0.49 and the average stock price is 822.0. Stocks are then sorted into 10 groups according to UE portfolios.

For the results sorted into the UE deciles, we find that at the time of announcement, larger earnings surprises are almost monotonically associated with smaller firm size and trading volume, firms with extreme earnings surprises are generally have larger bid-ask spread and lower stock prices. This pattern is consistent with Bernard and Thomas (1990). For example, the average market capitalization in group 1 and group 10 is £5104.7 million and £4898.9 million, which is much smaller than the firms in the group 5 and group 6, which have market

values of £9643.7 million and £9704.1 million respectively. This is consistent with Truong (2010) who reveals that extreme earnings surprises stocks often have small market value.

The spread in trading volume between the 1 and 5 decile formed on the basis of UE is 2935, 3129 million shares in group 1 and for group 5 it is 6064 million shares. The bid-ask spread in group 1 and group 5 is 0.81 and 0.21 respectively. Sadka et al. (2005) believe that bad news firms (low UE groups) are subject to more information asymmetry than good-news firms (high UE groups), therefore high UE firms are more liquid and outperform low UE firms. However, in our UE portfolios, the extreme groups (e.g.: group 1 or 10) are all more illiquid (have higher bid-ask spread) than the middle-rank UE groups (e.g.: group 5 or 6), regardless of positive or negative news groups.

[INSERT TABLE 1 HERE]

5.2 The price effects around the earnings announcement

We first examine the information present in earnings announcements measured by stock price changes in the event window. More specifically we construct several event windows, 3-days (-1, +1), 5-days (-2, +2) around the earnings announcement, and 10 days (+1, +10), 30-days (+1, +30), 60 days (+1, +60) following the earnings announcement. Based on the return data in the event window (-1, +1), we sort the positive earnings into the good news portfolio and the negative earnings into the bad news portfolio. We define negative (positive) news as the case in which reported earnings are lower (higher) than the quarterly earnings four quarters before, and neutral news refers to the case in which reported earnings are roughly equal to the four quarters before. In order to measure the bid-ask bias effect, we capture the mid-point- based returns in Panel A and closing-price-based returns in Panel B. Table 2 shows that in total, there are 17304 earnings announcements during our sample period, with 7868 good, 8239 bad and 1197 neutral news. In the positive and negative news column, all results are statistically significant at the 1% level, which show that in general the market reacts to the earnings announcements, a positive reaction occurs for good news and a negative reaction follows bad news.

Panel A of Table 2 shows that on average, the mid-point-based CARs around the all earnings announcement is negative, -1.134% for (-1, +1), -1.016% for (-2, +2), and -0.946% for (+1,+60). When we focus on the good and bad news columns, asymmetry in the price reaction between good and bad news group presented on all event windows, the absolute value of bad news is all larger than good news. For example, for (-1, +1), the reaction is 0.701% for good news, -0.027% for neutral news and -1.444% for bad news. In the (+1,+60) columns, the reaction is 0.712% for good news and -1.696% for bad news, suggesting that stocks with good news have less drift, investors tend to under-react to positive news and over-react to negative news. The significant asymmetric reactions between

good and bad news are consistent with Chan (2003), although we examine the different stock market and sample period.

The results of closing price returns in Panel B show a similar pattern with the mid-points returns, the CARs of all event windows are negative, positive for good news and negative for bad news. However, comparing with the results in Panel A, the absolute value of closing price returns is all smaller than the mid-point-based returns. For instance, the CAR (-1, +1) is 0.953% for all news, 0.649% for good news and -1.366% for bad news. This clearly shows that the bid-ask effects and order flow ratio have some implications on the stock markets, and lasting until +60 days with PEAD. Lease et al. (1991) explain that as when investors know the news, they start to decrease their inventory level in these firms' stocks, therefore the overall abnormal returns of sample firms is negative, and the midpoint-based return in panel A shows a more obvious negative value compared with the closing-based price in panel B. As in Chordia and Subrahmanyam (2004), price and return data are based on the mid-quote prices can remove the effect of bid-ask bounce, therefore, we can conclude that the rest of abnormal return is mainly due to the drift effect.

[INSERT TABLE 2 HERE]

5.3 Trades tendency and order flow ratio around the earnings announcement

Table 3 reports the percentage of transaction closing price occurring at the ask, the bid and the midpoint from one day before the announcement (day -1) to the 60 days after the announcement (day +60) for all earnings announcements. From the table we observe that on the one day before the news released, the closing price occurring at the bid price are much more than at the ask price, with an order flow ratio equal to 54.2. On the event day, the percentage of closing prices occurring at the ask quote and bid quote is 22.61 and 40.20 respectively, with an order flow ratio of 57.6. However, after a dramatic increase in bid quote and decreases in ask quote from day -1 to day 0, there is a reversal in day +1, the percentage of closing prices at the ask quote rises from 22.61 to 27.62, whereas the percentage at the bid price declines from 40.20 to 32.13, order flow ratio increased from 54.2 in day -1 to 57.6 in day 0, then decreased to 52.7 on day +1.

Overall, the order flow ratios continue to be larger than 0.5 (closer to 1) during the post- earnings announcement until day +40 (order flow ratio is 48.9). It indicates that during the post-earnings period, the amount of sell orders is much higher than buy orders. This consistent with our second hypothesis, the earnings announcements cause the order flow imbalance for FTSE350 firms. Relating with the results in section 5.2, the overall negative stock returns around the earnings announcement is likely to

be associated with substantial selling pressure, showing the probability that a closing price is at a bid price. Moreover, Engel and Patton (2004) discover that buy orders increased the mid-point whereas sell orders decreased the mid-point. In our Table 2, the absolute value of mid-point-based return is larger than the closing-price-based return, especially for negative news and negative value, it can be partly explained by more sell orders which reduce the mid-point dramatically around the announcement. On the 60 days after the earnings announcement, the percentage of closing prices occurring at the ask is 33.77 and bid is 31.14, the order flow ratio is 49.3, which is smaller than 0.5 and closer to 0, the degree of imbalance vanishes through time.

[INSERT TABLE 3 HERE]

5.4 Trades tendency and order flow ratio around the earnings announcement : by different news type

The results in Table 3 show that on average the earnings announcement causes more orders occur at the bid quote than the ask quote, now we re-examine the order flow ratio for positive and negative news separately. For positive news which represented at Table 4, from the event day (day 0), the order flow ratios are all smaller than 0.5. On day +1, the ratio is 44.6 whereas the ratio is 48.3 on day +10. These results are consistent with the previous research (e.g.: Lee, 1992) which indicates that a period of intense buying are associated with positive news. The buying pressure lasting longer than 60 days (48.2 for day +60) after the news announcement, the order flow imbalance and buying pressure is not subsiding quickly in the post- announcement period.

For negative news in Table 5, on the day 0, the percentage of closing prices occurring at ask and bid quote is 24.07 and 43.22 respectively, with the order flow ratio equals to 59.2. The amount of sell orders is much higher than the buy orders, the stock market responds to bad news by a period of intense selling. On the day +1, similar with the all announcement results, the order flow ratio decreases from 59.2 on event day to 55.0 on day 1, the percentage at the ask quote rises from 24.07 to 26.84 whereas the percentage at the bid quote reduces from 43.22 to 39.77. This reversal re-confirms that the bounce between ask and bid quote is one of the reasons for anomaly during the past-announcement period. Overall, the order flow ratio is closer to 1 (larger than 0.5) during the post-earnings announcement until day 60, with an order flow ratio equal to 48.3, shows that the selling pressure diminishes in the long run. It contrasts with Bissoondoyal-Bheenick et al. (2019) who document that the effect of buy orders on positive surprises is smaller than that of sell orders on negative shocks.

[INSERT TABLE 4 HERE]

[INSERT TABLE 5 HERE]

5.5 Regression of PEAD returns and order flow ratio

Table 6 exhibits the regression results between PEAD returns and order flow ratio. For simplicity we only report the results of PEAD3 as short-term window and PEAD 60 as long- term window. Overall, we find that the coefficient on order flow imbalance ratio is significant and positive, it indicate that, the order flow ratio is closer to 1 (larger), there are more sell orders in the market, causing a larger PEAD of stocks. For example, the coefficient between OF and PEAD3 is 0.248 with t-statistics equal to 3.54, and 0.369 with a t-statistic of 3.83 for all announcements. An interesting point is, comparing with the results of all news and negative earnings news, the order flow ratio coefficients of positive news show the different pattern on the PEAD return, since the positive news is usually related with more buy orders, the relationship between OF and PEAD return is negative in both the short-run and long run. We also find that the coefficient on StdDev is significantly negative at least at the 5% significance level for both short-term and long-term period. This finding suggests that as the standard deviation of stock increases, firm has a smaller PEAD return during the drift window.

[INSERT TABLE 6 HERE]

5.6 Regression of PEAD returns, order flow ratio and UE

In Table 7, we obtain the earnings response coefficient regressions following Ng et al. (2008), in order to capture the relation between UE, order flow ratio and PEAD returns. Our general regression specification is based on the estimation of equation (8) and (9). The mid- point based return as the determined variable presented in Panel A and Panel B shows the closing price returns as the dependant variable. To reduce the effects of outliers, we rank our variables into deciles within each calendar quarter and rescale the data to range from 0 to 1.

Given the predictability of PEAD returns, we expect the coefficient of UE to be positive and statistically significant. However, for both the PEAD3 and PEAD5 models which cover the event day (day 0), variables are all insignificant for both the mid-point-based and closing- price-based model. For example, the coefficient between UE and PEAD3 is 0.016 with a t- statistic equal to 1.01 for mid-point-return models and 0.010 with a t-statistics of 0.94 for closing-price-based return. On the other hand, for PEAD60 model, the result is 0.505 (t- value=5.25) and 0.435 (t-value=4.08) for mid-point-based returns and closing-price-based returns respectively, both statistic significant at the 1% level. Our results provide the evidence of Ng et al. (2008) who find that PEAD3 contains several measurement errors, the measurements which start from one day after the announcement day avoid these problems. In the event period (+1, +10), the coefficient on UE is positive and significant at the

1% level in both mid-point (0.494 with a t-statistics=4.87) and closing-price-based return (0.335 with a t- statistics=3.41).

For the UE*OF variable, once again, the coefficient of PEAD3 models is 0.014 (t-value=0.93) for mid-point-based returns and 0.009 (t-value=0.91) for closing price-based returns. PEAD (+1,+60) of UE*OF equals to 0.448 (t-value=4.64) for mid-point returns whereas 0.363 (t- values=3.44) for closing price returns model, both of them significantly at 1% level. Furthermore, the positive coefficients of UE*OF indicate that, the order flow ratio is closer to 1 (larger), there are more sell orders in the market, causing a larger PEAD of stocks. From the prospective of bid-ask bias, the difference between the UE*OF coefficient of mid-point- based model and the closing-price-based model imply that there is a bid-ask error in the return measurement. For instance, in the PEAD (+1, +30) column, the coefficient is 0.456 in Panel A whereas 0.387 in Panel B. It means that when we purged the bid-ask bias by measuring the midpoint returns, the degree of bid-ask bias is reduced whereas the association between order flow and PEAD returns are more pronounced, since the coefficients of Panel A is larger than Panel B. Our results contrast with Levi and Zhang (2015) who show that when returns based on mid-quotes as a dependent variable, the effect of sell pressure is lower.

In terms of trading volume variables in the two models, all coefficients are highly significant, and mid-point-based returns models have more powerful results. They exhibit -0.643 for mid- point-based returns and -0.438 for closing-price-based returns in the PEAD3 model. For the long run, the coefficients of trading volume is -0.176 in the mid-point-based return model and -0.132 in the closing-price-based return model in (+1,+10). Comparing between short- and long-run models, the coefficients of UE*VOL are larger in PEAD3 and PEAD5 than PEAD(+1, +10) and other long run models, showing the trading volatility around the earnings announcement day. It can be explained by the study of Berkman and Truong (2009), the increasing number of earnings announcement events causes the stock price, trading volume and volatility to be biased on the event day.

The regression results fail to provide evidence that drift varies with firm size, all of the market value coefficients in Table 7 are insignificant. For example, the coefficient of firm size in PEAD(+1,+10) model is -0.035 with a t-statistic equal to -1.16 in Panel A and -0.039 with a t-statistics equal to -1.27 in Panel B. These results are similar with Chan et al. (2005) which demonstrate that firm size has no effect on the response to earnings announcements, but inconsistent with Bhushan (1994) who shows that transition costs are higher for smaller firms and this drives the sensitivity of drift to firm size. The same result also occurs in the coefficients of stock price and PEAD return, there is no evidence that stock prices are associated with the degree of PEAD. For example, in the PEAD (+1,+60) model, we

observe an insignificant positive coefficients (0.058 with a t-statistics =1.39） for mid-point-based PEAD returns.

However, we do find a significantly negative coefficient on the UE*StdDev and PEAD returns, and the coefficient of Panel A are all larger than Panel B. In the PEAD (+1, 10) model, the coefficient equals to -0.302 for mid-point return-based models, larger than -0.248 which in closing price-based models. It shows that when we purged the bid-ask bias effect, the stock volatility has more obvious effects on the PEAD return. Also, we document evidence consistent with Bhushan (1994) who believes that PEAD are decreasing in liquidity, in our models, the bid-ask spreads appear to negatively affect the PEAD returns in both two panels. For example, in PEAD (+1, +60), the coefficients of spread is -0.393 for midpoint- based returns and -0.277 for closing price-based returns.

[INSERT TABLE 7 HERE]

5.7 Regression of PEAD returns and order flow ratio: by different news type

In Table 8 and Table 9, we re-examine our general regression specification of equation (8) and (9), by dividing the earnings announcement events into the positive and negative categories. We report the results of positive news in Table 8 and negative news models in Table 9. From both two tables, we can see similarities with the results in section 5.5, the coefficients of UE are small and insignificant in PEAD3 and PEAD5 models, whereas during the long-term, the coefficients are all statistically significant. For example, for mid-point- based return of positive news, the coefficient of UE is 0.013 (t-value equals to 0.88) for PEAD3 whereas in PEAD (+1, +60) model, the coefficient is 0.355 with t-statistic=3.73. In negative news models, the coefficient of UE is 0.019 (t-value=1.20) for PEAD3 and 0.520 (t- value=5.29) for PEAD (+1, +60) in the mid-point-based return. Comparing between the results of Table 8 and Table 9, the coefficients of UE in negative news are all larger than that in positive news, indicating that the investors tend to over-reaction to the negative earnings shocks.

The UE*OF models show similar patterns with UE models. In negative event models, the coefficient of UE*OF is statistically insignificant with coefficients of 0.013 (t-statistics=1.04) and 0.006 (t-statistics= 0.58) for PEAD3 in mid-point and closing price return respectively. Again, similar with the results in Table 6, for positive news in Table 8, the coefficient of UE*OF is negative, -0.010 for PEAD3, -0.317 for PEAD (+1, +60) in mid-point-based return. The order flow ratio coefficients of positive news show the different pattern on the PEAD return comparing with all news and negative earnings shocks, the positive news usually related with more buy orders than sell order, therefore the relationship between UE*OF and PEAD return is negative.

One more interest point is that when we examine the positive and negative news separately, the stock price effect which has been examined insignificant in section 5.6, are statistically significant at 10% in positive news model. For example, the coefficient is 0.140 (t-statistics equals to 1.65) and 0.130 (t-statistics=1.77) in mid-point-based returns and closing price- based model for PEAD3 model. On the other hand, the degree of PEAD returns decreasing as the size of standard deviation of stock increases, -0.486 for PEAD3 and -0.340 for PEAD(+1,+60) in panel A whereas -0.397 for PEAD3 and -0.301 for PEAD (+1, +60) in panel B.

[INSERT TABLE 8 HERE]

[INSERT TABLE 9 HERE]

6. Additional tests

The findings presented in the previous sections show that there is a significant positive coefficient on UE and PEAD returns, order flow imbalance also has a significant relationship with the PEAD returns. In this section, we perform further analysis to quantify whether PEAD proxied by alternative analyst-based measures can explain the relationship between them. More specially, we use the analyst forecast-based measure (henceforth AUE) which is computed by scaling the difference between the actual quarterly earnings per share and the latest mean analyst forecast by the absolute value of the actual quarterly earnings per share:

$$AUE_{i,t} = \frac{AE_{i,t} - AForecast_{i,t-1}}{|Actual_{i.t}|} \quad (10)$$

The results are presented at Table 10-12. Untabulated results show the alternative version of *AUE* is, in fact, highly correlated with the original version of *UE*. The Pearson and Spearman correlation coefficients between these two variables are 0.868 and 0.932 respectively.

When AUE is used in the analysis, the test results do not change. Similar with the results in the last section, in table 10 for all earnings announcements, we observe significant positive coefficients between PEAD return and UE for PEAD10, 30, 60 model, the result is 0.466 (t-value=5.31), 0.511 (t-value=6.99), 0.495 (t-value=5.36) respectively for mid-point-based returns, statistic significant at 1% level. For closing price return the results are similar. The coefficient on UE*OF and PEAD return is significantly positive for PEAD10,30, 60 model, in both Panel A and B, consistent with the work of previous sections, indicating that the order flow ratio is closer to 1 (larger), there are more sell orders in the market, causing a larger PEAD of stocks. Again, the coefficients of Panel A are larger than Panel B, it provides more evidence to show that when we measure the PEAD return by midpoint returns for purging the bid-ask bias, the degree of bid-ask bias is reduced and the association between order flow and PEAD

returns are more pronounced[3].

[INSERT TABLE 10-12 HERE]

7. Conclusion

In this paper, we document and quantify the asymmetric effect of PEAD and order flow imbalance during the post-earnings announcement period. Using an earnings-announcement-based earnings surprise model, we show that the PEAD is significant during the post earnings announcement period, along with the bid-ask bias error contained in the stock returns. Asymmetry in the price reaction between good and bad news is presented through the whole period, stocks with good news have less drift, investors tend to under-react to good news and over-react to bad news. When we purged the bid-ask bias by measuring the midpoint returns, the degree of bid-ask bias is reduced and the association between order flow and PEAD returns are more pronounced. We also locate the closing price relative the bid and ask prices around the earnings announcement, uncover that the earnings announcements cause the order flow imbalance between buy and sell orders for FTSE350 firms. The overall negative stock return around the earnings announcement is likely to be associated with substantial selling pressure. When we examine the order flow ratio for positive and negative news separately, we find a period of intense buying are associated with positive news whereas intense selling are associated with negative news. The buying pressure does not subside quickly in the post-announcement period for positive news, but the order flow imbalance diminishes during the long-term for negative news. Also, we observe the significant rebound of buy and sell orders in one day after the negative news announcement, reveal that the bounce between ask and bid quote is one of the reasons for the anomaly during the post-announcement period.

From the OLS regression models, we point out that there is a significant negative coefficient on UE and PEAD returns, and order flow is also negatively related with the PEAD. However, the order flow coefficients of positive news show a different pattern on the PEAD return, the positive news usually related with more buy orders than sell order. We fail to provide evidence that drift varies with firm size, no evidence that stock prices are associated with the degree of PEAD as well. There is a significantly negative coefficient on the UE*StdDev and PEAD returns, when we purged the bid-ask bias effect, the stock volatility has a more obvious effects. Our main results are robust across different estimations.

[3] Measuring the CARS based on a value-weighted market portfolio could also affect the results. To address this concern, we re-run the equation (8) and (9) in 10, 60 trading day windows, the results are consistent with those reported in Table 7-9. For brevity we do not report the results, they are available from the authors upon request.

The evidence in this paper offers two main contributions beyond the previous literature. First, we represent the PEAD anomaly impact on the stock returns along with the bid-ask bounce. The magnitude of the stock return anomaly is because of both the bias between bid and ask prices and the drift in the post-earnings announcement period. Also, we show that the order flow disruption causes a bias in the calculation of returns around the company event announcement. We suggest that the bid-ask bounce is an important component of stock return anomalies during the post earnings announcement period, along with the drift effect.

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Table 1. Descriptive statistics for all samples

Table 1 presents the summary statistics of firms from FTSE350 during the time period of 2000-2021. Firms are assigned into *UE* decile portfolios based on the distribution of *UE* in the prior fiscal quarter. *Firm size* is the market value of sample firms at the earnings announcement month. *Trading volume* is the average daily trading volume during the announcement month. *Spread* is the average daily effective spread which is calculated as twice the absolute value of the actual execution price minus the mid-point of the quoted bid-ask spread immediately before the transaction. *Price* is the average closing daily price during the announcement month.

Decile	Firm size(£million)	Trading volume(million)	Spread	Price (£)
Average	7210.7	4936	0.49	822.0
1	5104.7	3192	0.81	586
2	6201.2	4204	0.80	743
3	7057.3	5498	0.50	820
4	8314.6	5832	0.34	903
5	9643.7	6064	0.21	999
6	9704.1	6003	0.21	1046
7	8025.0	5740	0.37	894
8	6928.6	5523	0.51	836
9	6124.3	4006	0.73	747
10	4898.9	3208	0.79	623

Table 2. The price effect associated with post-earnings drift period

Table 2 provides the daily cumulative average returns (CAR) of various event windows calculated by midpoint-price (Panel A) and closing price (Panel B), which provides the bid-ask bias purged return. The sample consists of firms listed on the FTSE350 trading on their earnings announcement days for the period January 2000 to December 2021. T-statistics are presented to show if sample firms' CAR are significantly different from zero. Two tailed tests of significance are reported as follows, ***less than 1%, **less than 5% and * less than 10%.

	All (N.=17304)	Good (N.=7868)	Neutral (N.=1197)	Bad (N.=8239)
Panel A: mid-point return				
CAR (-1,+1)	-1.134	0.701	-0.027	-1.444
T-stat	-11.29***	6.54***	-1.24	-14.71***
CAR (-2,+2)	-1.016	0.788	-0.075	-1.504
T-stat	-8.84***	7.09***	-1.40	-16.03***
CAR (+1,+10)	-1.064	0.677	-0.134	-1.986
T-stat	-9.25***	5.83***	-2.06*	-19.07***
CAR (+1,+30)	-1.003	0.754	-0.019	-1.777
T-stat	-10.64***	5.06***	-2.13*	-17.24***
CAR (+1, +60)	-0.946	0.712	-0.103	-1.696
T-stat	-8.03***	6.67***	-1.94*	-12.39***
Panel B: closing price return				
CAR (-1,+1)	-0.953	0.649	-0.019	-1.366
T-stat	-9.46***	6.03***	-1.20	-13.99***
CAR (-2,+2)	-0.928	0.702	-0.068	-1.427
T-stat	-8.37***	7.25***	-1.39	-14.23***
CAR (+1,+10)	-0.909	0.631	-0.106	-1.821
T-stat	-7.64***	5.84***	-1.88	-19.03***
CAR (+1,+30)	-0.993	0.689	-0.100	-1.404
T-stat	-10.00***	6.37***	-1.70	-14.78***
CAR (+1,+60)	-0.888	0.646	-0.084	-1.239
T-stat	-6.89***	6.00***	-1.53	-13.06***

Table 3. Closing price relative to bid and ask quotes during the post-earnings announcements drift period: All earnings announcements

Table 3 reports the event day relative to the announcement day (day 0), percentage distribution of closing prices in relation to the bid and ask quotes and order flow ratios for FTSE350 listed firms trading on their earnings announcement days for the period January 2000 to December 2021. The order flow ratio is calculated as (ask price-trading price)/(ask price – bid price). Two tailed tests of significance are reported as follows, ***less than 1%, **less than 5% and * less than 10%.

Panel A: Distribution of closing prices

Day	At ask	At bid	Order flow ratio
-1	24.74	33.56	54.2
0	22.61	40.20	57.6
1	27.62	32.13	52.7
2	23.90	38.06	56.9
3	25.46	33.08	53.3
4	24.99	33.33	53.9
5	24.70	34.12	54.7
10	28.12	31.41	51.6
20	30.46	31.07	50.2
30	32.08	27.99	52.0
40	33.04	30.17	48.9
50	32.85	30.10	49.1
60	33.77	31.14	49.3

Panel B: Test of mean order flow ratio on day 0 to the comparison period

	Pre-announcement period	Post-announcement period
T-test	7.78^{***}	14.06^{***}

Table 4. Closing price relative to bid and ask quotes during the post-earnings announcements drift period: Positive earnings announcements

Table 4 reports the event day relative to the announcement day (day 0), percentage distribution of closing prices in relation to the bid and ask quotes and order flow ratios for FTSE350 listed firms trading on their earnings announcement days for the period January 2000 to December 2021. The order flow ratio is calculated as (ask price-trading price)/(ask price – bid price). Two tailed tests of significance are reported as follows, ***less than 1%, **less than 5% and * less than 10%.

Panel A: Distribution of closing prices

Day	At ask	At bid	Order flow ratio
-1	29.70	33.25	51.6
0	40.11	29.34	44.2
1	41.09	29.47	44.6
2	42.75	30.00	44.0
3	42.94	29.38	44.3
4	39.27	30.05	45.1
5	40.00	31.26	45.6
10	37.62	33.83	48.3
20	30.65	27.78	48.2
30	30.06	26.98	48.6
40	31.99	30.03	49.2
50	30.37	28.46	49.3
60	31.65	29.04	48.2

Panel B: Test of mean order flow ratio on day 0 to the comparison period

	Pre-announcement period	Post-announcement period
T-test	4.69^{***}	8.34^{***}

Table 5. Closing price relative to bid and ask quotes during the post-earnings announcements drift period: Negative earnings announcements

Table 5 reports the event day relative to the announcement day (day 0), percentage distribution of closing prices in relation to the bid and ask quotes and order flow ratios for FTSE350 listed firms trading on their earnings announcement days for the period January 2000 to December 2021. The order flow ratio is calculated as (ask price-trading price)/(ask price – bid price). Two tailed tests of significance are reported as follows, ***less than 1%, **less than 5% and * less than 10%.

Panel A: Distribution of closing prices

Day	At ask	At bid	Order flow ratio
-1	24.37	30.45	53.0
0	24.07	43.22	59.2
1	26.84	39.77	55.0
2	23.26	41.71	58.6
3	24.75	39.88	56.7
4	23.08	39.26	57.4
5	25.06	38.87	55.9
10	28.08	33.05	52.1
20	28.66	34.09	52.4
30	29.28	32.96	51.2
40	27.94	32.08	51.5
50	32.98	31.04	50.4
60	33.76	29.13	48.3

Panel B: Test of mean order flow ratio on day 0 to the comparison period

	Pre-announcement period	Post-announcement period
T-test	8.96***	17.25***

Table 6. Regression between PEAD and order flow imbalance

Table 6 represents the results of OLS analysis to examine PEAD return and order flow ratio of firms listed on the FTSE350 trading on their earnings announcement days for the period January 2000 to December 2021, using the following pooled regression model:

$$PEAD_{i,t}=\beta_0+\beta_1 OF_{i,t}+\beta_2 Vol_{i,t}+\beta_3 Size_{i,t}+\beta_4 StdDev_{i,t}+\beta_5 Price_{i,t}+\beta_6 Spread_{i,t}+\varepsilon_t$$

$PEAD_{i,t}$ represents either *PEAD3* or *PEAD60*, for stock *i* in time period *t*. Independent variables include *OF* is the order flow ratio of firm *i* at time *t*. $Vol_{i,t}$, is the daily trading volume of stock *i* at time *t*, $Size_{i,t}$ captures the market capitalization of firm *i* at time *t*. $StdDev_{i,t}$ represents daily return volatility of firm *i* at time period t. $Price_{i,t}$, is stock *i*'s daily closing price. $Spread_{i,t}$ is the relative spread of firm *i* at time *t*. Two tailed tests of significance are reported as follows, *** denotes significance at 1%, ** denotes significance at 5% and * denotes significance at 10%.

Panel A: PEAD3						
	All		Positive		Negative	
	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.
C	-0.965	-8.26***	-0.677	-6.45***	-0.834	-6.97***
OF	0.248	3.54***	-0.201	-3.28**	0.316	4.03***
Vol	-0.089	-1.76*	-0.102	-2.01*	-0.084	-1.77*
Size	0.003	0.57	0.006	0.64	0.001	0.43
StdDev	-0.216	-3.16**	-0.231	-3.45***	-0.205	-3.11**
Price	0.007	1.28	0.010	1.34	0.006	1.19
Spread	0.013	1.24	0.010	1.11	0.014	1.15
Panel B: PEAD60						
	All		Positive		Negative	
	Coeff.	t-stat.	Coeff.	t-stat.	Coeff.	t-stat.
C	-0.843	-6.59***	-0.909	-7.22***	-0.788	-7.03***
OF	0.369	3.83***	-0.324	-3.46***	0.388	4.00***
Vol	-0.103	-1.64*	-0.111	1.72*	-0.100	-1.43
Size	0.006	0.79	0.004	0.58	0.006	0.77
StdDev	-0.310	-3.34***	-0.316	-3.38***	-0.307	-3.36***
Price	0.011	1.39	0.010	1.34	0.013	1.46
Spread	0.009	0.88	0.008	1.04	0.010	1.09

Table 7. Regression between PEAD and firm variables by quote price effects: All earnings announcements

Table 7 represents the results of earnings response coefficient regressions to examine PEAD and order flow ratio for earnings surprises of firms listed on the FTSE350 trading on their earnings announcement days for the period January 2000 to December 2021, using the following pooled regression model:

$$PEAD_{i,t}=\beta_0+\beta_1 UE_{i,t}+\beta_2\, UE^{*}OF_{i,t}+\beta_3\, UE^{*}Vol_{i,t}+\beta_4\, UE^{*}Size_{i,t}+\beta_5\, UE^{*}StdDev_{i,t}+\beta_6\, UE^{*}Price_{i,t}+\beta_7\, UE^{*}Spread_{i,t}+\varepsilon_t.$$

$$PEAD^{m}=\beta_0+\beta_1 UE_{i,t}+\beta_2\, UE^{*}OF_{i,t}+\beta_3\, UE^{*}Vol_{i,t}+\beta_4\, UE^{*}Size_{i,t}+\beta_5\, UE^{*}StdDev_{i,t}+\beta_6\, UE^{*}Price_{i,t}+\beta_7\, UE^{*}Spread_{i,t}+\varepsilon_t.$$

$PEAD_{i,t}$ represents either *PEAD3*, *PEAD5, PEAD10,PEAD30* or *PEAD60*, for stock *i* in time period *t*. $PEAD^{m}$ represents the various *PEAD* measured by mid-point price. Independent variables include *UE*, which is the earnings surprise measured using earnings expectations from a seasonal random walk model. *UE*OF* is the order flow ratio of firm *i* at time *t*. $UE^{*}Vol_{i,t}$, is the daily trading volume of stock *i* at time *t*, $UE^{*}Size_{i,t}$ captures the market capitalization of firm *i* at time *t*. $UE^{*}StdDev_{i,t}$ represents daily return volatility of firm *i* at time period t. $UE^{*}Price_{i,t}$, is stock *i*'s daily closing price. $UE^{*}Spread_{i,t}$ is the relative spread of firm *i* at time *t*. Two tailed tests of significance are reported as follows, *** denotes significance at 1%, ** denotes significance at 5% and * denotes significance at 10%.

Panel A: mid-point return

	PEAD3		PEAD5		PEAD(+1,10)		PEAD(+1,30)		PEAD(+1,60)	
	Coef.	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
C	-1.560	-11.25***	-1.488	-9.73***	-0.642	-6.97***	-1.048	-9.44***	-1.025	-11.73***
UE	0.016	1.01	0.013	0.86	0.494	4.87***	0.513	5.32***	0.505	5.25***
UE*OF	0.014	0.93	0.015	1.03	0.433	4.69***	0.456	4.27***	0.448	4.64***
UE*Vol	-0.643	-6.01***	-0.585	-5.43***	-0.176	-1.99*	-0.203	-2.23**	-0.184	-2.01*
UE*Size	-0.013	-0.82	-0.026	-1.30	-0.035	-1.16	-0.030	-1.26	-0.031	-1.23
UE*StdDev.	-0.530	-5.19***	-0.621	-6.16***	-0.302	-3.18**	-0.315	-3.25**	-0.323	-3.43***
UE*Price	0.075	1.34	0.056	1.30	0.067	1.31	0.045	1.37	0.058	1.39
UE*Spread	-0.265	-2.51**	-0.233	-2.39**	-0.416	-4.38***	-0.425	-4.07***	-0.393	-4.06***

Panel B: closing price return

	PEAD3		PEAD5		PEAD(+1,10)		PEAD(+1,30)		PEAD(+1,60)	
	Coef.	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
C	-1.679	-13.63***	-1.206	-9.27***	-0.780	-7.64***	-0.973	-5.01***	-1.007	-8.54***
UE	0.010	0.94	0.008	0.49	0.335	3.41***	0.406	4.37***	0.435	4.08***
UE*OF	0.009	0.91	0.003	0.36	0.344	3.62***	0.387	3.95***	0.363	3.44***
UE*Vol	-0.438	-4.99***	-0.406	-4.82***	-0.132	-1.43	-0.144	-1.66*	-0.128	-1.40
UE*Size	-0.024	-1.03	-0.019	-1.06	-0.039	-1.27	-0.025	-1.30	-0.032	-0.92
UE*StdDev	-0.406	-4.42***	-0.444	-4.43***	-0.248	-4.05***	-0.256	-3.64***	-0.299	-3.08**
UE*Price	0.096	1.35	0.077	1.03	0.090	1.01	0.083	1.60*	0.091	1.66*
UE*Spread	-0.144	-1.66*	-0.166	-1.73*	-0.246	-2.58**	-0.239	-2.46**	-0.277	-2.58**

Table 8. Regression between PEAD and firm variables by quote price effect: Positive earnings announcements

Table 8 represents the results of earnings response coefficient regressions to examine PEAD and order flow ratio for earnings surprises of firms listed on the FTSE350 trading on their earnings announcement days for the period January 2000 to December 2021, using the following pooled regression model:

$PEAD_{i,t}=\beta_0+\beta_1 UE_{i,t}+\beta_2\ UE{*}OF_{i,t}+\beta_3\ UE{*}Vol_{i,t}+\beta_4\ UE{*}Size_{i,t}+\beta_5\ UE{*}StdDev_{i,t}+\beta_6\ UE{*}Price_{i,t}+\beta_7\ UE{*}Spread_{i,t}+\varepsilon_t$

$PEAD^m=\beta_0+\beta_1 UE_{i,t}+\beta_2\ UE{*}OF_{i,t}+\beta_3\ UE{*}Vol_{i,t}+\beta_4\ UE{*}Size_{i,t}+\beta_5\ UE{*}StdDev_{i,t}+\beta_6\ UE{*}Price_{i,t}+\beta_7\ UE{*}Spread_{i,t}+\varepsilon_t$

$PEAD_{i,t}$ represents either *PEAD3*, *PEAD5, PEAD10, PEAD30* or *PEAD60*, for stock *i* in time period *t*. $PEAD^m$ represents the various *PEAD* measured by mid-point price. Independent variables include *UE*, which is the earnings surprise measured using earnings expectations from a seasonal random walk model. *UE*OF* is the order flow ratio of firm *i* at time *t*. $UE{*}Vol_{i,t}$, is the daily trading volume of stock *i* at time *t*, $UE{*}Size_{i,t}$ captures the market capitalization of firm *i* at time *t*. $UE{*}StdDev_{i,t}$ represents daily return volatility of firm *i* at time period *t*. $UE{*}Price_{i,t}$, is stock *i*'s daily closing price. $UE{*}Spread_{i,t}$ is the relative spread of firm *i* at time *t*. Two tailed tests of significance are reported as follows, *** denotes significance at 1%, ** denotes significance at 5% and * denotes significance at 10%.

Panel A: mid-point return										
	PEAD3		**PEAD5**		**PEAD(+1,10)**		**PEAD(+1,30)**		**PEAD(+1,60)**	
	Coef.	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
C	0.746	7.18***	0.848	9.99***	0.735	6.97***	1.033	7.02***	0.945	6.23***
UE	0.013	0.88	0.014	1.03	0.333	3.48***	0.364	3.62***	0.355	3.73***
UE*OF	-0.010	-0.86	-0.012	-0.79	-0.314	-3.26**	-0.323	-3.19**	-0.317	-3.34***
UE*Vol	-0.574	-5.82***	-0.603	-6.41***	-0.199	-2.05*	-0.183	-1.73*	-0.176	-1.87*
UE*Size	0.014	0.91	0.017	0.98	0.038	1.26	0.034	1.25	0.027	0.93
UE*StdDev.	-0.486	-4.93***	-0.425	-4.96***	-0.397	-4.05***	-0.382	-3.90***	-0.340	-3.66***
UE*Price	0.140	1.65*	0.138	1.69*	0.169	1.87*	0.173	1.65*	0.170	1.94*
UE*Spread	-0.218	-2.34**	-0.196	2.17*	-0.305	-3.10**	-0.314	-3.23**	-0.322	-3.37***
Panel B: closing price return										
	PEAD3		**PEAD5**		**PEAD(+1,10)**		**PEAD(+1,30)**		**PEAD(+1,60)**	
	Coef.	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
C	0.633	4.95***	0.706	5.27***	0.680	5.64***	0.973	5.01***	0.877	5.54***
UE	0.009	0.64	0.012	0.75	0.343	3.95***	0.309	3.58***	0.411	4.26***
UE*OF	-0.004	-0.43	-0.000	-0.36	-0.307	-3.41***	-0.316	-3.60***	-0.310	-3.55***
UE*Vol	-0.363	-3.96***	-0.346	-3.87***	-0.107	-1.64*	-0.129	-1.58*	-0.123	-1.50
UE*Size	0.021	0.67	0.023	0.64	0.034	0.89	0.022	0.84	0.028	0.74
UE*StdDev	-0.397	-4.16***	-0.401	-4.25***	-0.306	-3.20**	-0.298	-3.01**	-0.301	-3.14**
UE*Price	0.130	1.77*	0.120	1.69*	0.123	1.97*	0.147	1.84*	0.150	1.87*
UE*Spread	-0.121	-1.50	-0.104	1.43	-0.205	-2.10*	0.218	-2.36**	-0.230	-2.45**

Table 9. Regression between PEAD and firm variables by quote price effects: Negative earnings announcements

Table 9 represents the results of earnings response coefficient regressions to examine PEAD and order flow ratio for earnings surprises of firms listed on the FTSE350 trading on their earnings announcement days for the period January 2000 to December 2021, using the following pooled regression model:

$PEAD_{i,t}=\beta_0+\beta_1 UE_{i,t}+\beta_2\ UE^*OF_{i,t}+\beta_3\ UE^*Vol_{i,t}+\beta_4\ UE^*Size_{i,t}+\beta_5\ UE^*StdDev_{i,t}+\beta_6\ UE^*Price_{i,t}+\beta_7\ UE^*Spread_{i,t}+\varepsilon_t.$

$PEAD^m_{i,t}=\beta_0+\beta_1 UE_{i,t}+\beta_2\ UE^*OF_{i,t}+\beta_3\ UE^*Vol_{i,t}+\beta_4\ UE^*Size_{i,t}+\beta_5\ UE^*StdDev_{i,t}+\beta_6\ UE^*Price_{i,t}+\beta_7\ UE^*Spread_{i,t}+\varepsilon_t.$

$PEAD_{i,t}$ represents either *PEAD3*, *PEAD5, PEAD10,PEAD30* or *PEAD60*, for stock *i* in time period *t*. $PEAD^m_{i,t}$ represents the various *PEAD* measured by mid-point price. Independent variables include *UE*, which is the earnings surprise measured using earnings expectations from a seasonal random walk model. *UE*OF* is the order flow ratio of firm *i* at time *t*. $UE^*Vol_{i,t}$, is the daily trading volume of stock *i* at time *t*, $UE^*Size_{i,t}$ captures the market capitalization of firm *i* at time *t*. $UE^*StdDev_{i,t}$ represents daily return volatility of firm *i* at time period *t*. $UE^*Price_{i,t}$, is stock *i*'s daily closing price. $UE^*Spread_{i,t}$ is the relative spread of firm *i* at time *t*. Two tailed tests of significance are reported as follows, *** denotes significance at 1%, ** denotes significance at 5% and * denotes significance at 10%.

Panel A: mid-point return

	PEAD3		PEAD5		PEAD(+1,10)		PEAD(+1,30)		PEAD(+1,60)	
	Coef.	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
C	-1.673	-14.64***	-1.118	-10.64***	-0.728	-8.27***	-1.069	-10.26***	-1.248	-9.26***
UE	0.019	1.20	0.018	1.23	0.501	5.21***	0.568	5.76***	0.520	5.29***
UE*OF	0.013	1.04	0.016	1.10	0.447	4.49***	0.458	4.64***	0.415	4.27***
UE*Vol	-0.699	-6.83***	-0.604	-6.42***	-0.200	-2.06*	-0.197	-2.01*	-0.188	-1.95*
UE*Size	0.012	0.89	0.026	0.80	0.037	0.91	0.031	0.87	0.029	0.73
UE*StdDev.	-0.501	-5.12***	-0.599	-6.01***	-0.348	-3.61***	-0.306	-3.13**	-0.325	-3.30***
UE*Price	0.129	1.46	0.103	1.47	0.114	1.48	0.092	1.31	0.107	1.28
UE*Spread	0.263	2.77**	0.219	2.30**	0.437	4.23***	0.424	4.18***	0.409	4.18***

Panel B: closing price return

	PEAD3		PEAD5		PEAD(+1,10)		PEAD(+1,30)		PEAD(+1,60)	
	Coef.	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
C	-1.111	-9.26***	-1.245	-9.66***	-0.875	-7.68***	-1.168	-10.07***	-1.246	-10.45***
UE	0.009	0.64	0.004	0.57	0.397	4.04***	0.415	4.33***	0.427	4.69***
UE*OF	0.006	0.58	0.009	0.84	0.334	3.56***	0.377	3.91***	0.365	3.74***
UE*Vol	-0.441	-4.68***	-0.412	-4.45***	-0.113	1.33	-0.166	-1.84*	-0.137	-1.59*
UE*Size	0.026	1.20	0.013	1.03	0.037	1.06	0.031	1.07	0.034	1.22
UE*StdDev	-0.425	-4.34***	-0.431	-4.66***	-0.356	-3.67***	-0.388	-3.96***	-0.309	-3.14**
UE*Price	0.101	1.11	0.081	0.96	0.093	1.09	0.088	0.97	0.086	0.91
UE*Spread	0.207	2.27**	0.199	2.08*	0.293	3.04**	0.265	2.88**	0.298	3.04**

Table 10. Alternatively defined UE measures: Regression between PEAD and firm variables by quote price effects: All earnings announcements

Table 10 represents the results of earnings response coefficient regressions to examine PEAD and order flow ratio for earnings surprises of firms listed on the FTSE350 trading on their earnings announcement days for the period January 2000 to December 2021, using the following pooled regression model:

$$PEAD_{i,t}=\beta_0+\beta_1 UE_{i,t}+\beta_2\, UE{*}OF_{i,t}+\beta_3\, UE{*}Vol_{i,t}+\beta_4\, UE{*}Size_{i,t}+\beta_5\, UE{*}StdDev_{i,t}+\beta_6\, UE{*}Price_{i,t}+\beta_7\, UE{*}Spread_{i,t}+\varepsilon_t.$$

$$PEAD^{m}=\beta_0+\beta_1 UE_{i,t}+\beta_2\, UE{*}OF_{i,t}+\beta_3\, UE{*}Vol_{i,t}+\beta_4\, UE{*}Size_{i,t}+\beta_5\, UE{*}StdDev_{i,t}+\beta_6\, UE{*}Price_{i,t}+\beta_7\, UE{*}Spread_{i,t}+\varepsilon_t.$$

$PEAD_{i,t}$ represents either *PEAD3*, *PEAD5, PEAD10,PEAD30* or *PEAD60*, for stock *i* in time period *t*. $PEAD^{m}$ represents the various *PEAD* measured by mid-point price. Independent variables include *UE*, which is the earnings surprise measured using the analyst forecast error method. *UE*OF* is the order flow ratio of firm *i* at time *t*. $UE{*}Vol_{i,t}$, is the daily trading volume of stock *i* at time *t*, $UE{*}Size_{i,t}$ captures the market capitalization of firm *i* at time *t*. $UE{*}StdDev_{i,t}$ represents daily return volatility of firm *i* at time period t. $UE{*}Price_{i,t}$, is stock *i*'s daily closing price. $UE{*}Spread_{i,t}$ is the relative spread of firm *i* at time *t*. Two tailed tests of significance are reported as follows, *** denotes significance at 1%, ** denotes significance at 5% and * denotes significance at 10%.

Panel A: mid-point return

	PEAD3		PEAD5		PEAD(+1,10)		PEAD(+1,30)		PEAD(+1,60)	
	Coef.	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
C	-3.400	-13.86***	-2.065	-11.45***	-2.748	-13.23***	-4.125	-14.68***	-3.001	-12.19***
UE	0.010	0.58	0.011	0.67	0.466	5.31***	0.511	6.99***	0.495	5.36***
UE*OF	0.012	0.61	0.009	0.59	0.457	5.22***	0.448	5.18***	0.459	5.13***
UE*Vol	-0.574	-6.63***	-0.583	-6.14***	-0.206	-3.08**	-0.195	-2.46**	-0.214	-3.09**
UE*Size	-0.013	-0.70	-0.010	-0.64	-0.024	-0.89	-0.029	-1.01	-0.031	-1.33
UE*StdDev	-0.592	-7.01***	-0.608	-6.79***	-0.343	-4.19***	-0.399	-4.21***	-0.368	-4.26***
UE*Price	0.066	1.39	0.054	1.27	0.064	1.26	0.049	1.41	0.050	1.37
UE*Spread	-0.261	-3.03**	-0.234	-2.96**	-0.428	-4.98***	-0.420	-4.94***	-0.403	-4.80***

Panel B: closing price return

	PEAD3		PEAD5		PEAD(+1,10)		PEAD(+1,30)		PEAD(+1,60)	
	Coef.	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
C	-1.746	-8.28***	-2.088	-11.72***	-1.645	-7.79***	-1.999	-10.54***	-2.038	-10.29***
UE	0.009	0.61	0.010	0.52	0.391	4.53***	0.423	5.40***	0.429	5.18***
UE*OF	0.008	0.59	0.011	0.54	0.334	4.05***	0.333	4.25***	0.336	4.59***
UE*Vol	-0.462	-5.06***	-0.411	-4.83***	-0.202	-2.69**	-0.197	-2.71**	-0.193	-2.68**
UE*Size	-0.019	-0.83	-0.014	-0.82	-0.023	-0.75	-0.027	0.61	-0.030	0.72
UE*StdDev	-0.423	-4.98***	-0.475	-5.16***	-0.222	-2.94**	-0.273	-3.86***	-0.299	-3.44***
UE*Price	0.083	1.44	0.080	1.35	0.087	1.37	0.079	1.30	0.088	1.42
UE*Spread	-0.170	-2.05*	-0.169	-1.98*	-0.253	-3.26**	-0.236	-3.11**	-0.271	-3.07**

Table 11. Alternatively defined UE measures: Regression between PEAD and firm variables by quote price effects： Positive earnings announcements

Table 11 represents the results of earnings response coefficient regressions to examine PEAD and order flow ratio for earnings surprises of firms listed on the FTSE350 trading on their earnings announcement days for the period January 2000 to December 2021, using the following pooled regression model:

$PEAD_{i,t}=\beta_0+\beta_1 UE_{i,t}+\beta_2\ UE^*OF_{i,t}+\beta_3\ UE^*Vol_{i,t}+\beta_4\ UE^*Size_{i,t}+\beta_5\ UE^*StdDev_{i,t}+\beta_6\ UE^*Price_{i,t}+\beta_7\ UE^*Spread_{i,t}+\varepsilon_t.$

$PEAD^m=\beta_0+\beta_1 UE_{i,t}+\beta_2\ UE^*OF_{i,t}+\beta_3\ UE^*Vol_{i,t}+\beta_4\ UE^*Size_{i,t}+\beta_5\ UE^*StdDev_{i,t}+\beta_6\ UE^*Price_{i,t}+\beta_7\ UE^*Spread_{i,t}+\varepsilon_t.$

$PEAD_{i,t}$ represents either *PEAD3*, *PEAD5, PEAD10, PEAD30* or *PEAD60*, for stock *i* in time period *t*. $PEAD^m$ represents the various *PEAD* measured by mid-point price. Independent variables include *UE*, which is the earnings surprise measured using the analyst forecast error method. *UE*OF* is the order flow ratio of firm *i* at time *t*. $UE^*Vol_{i,t}$ is the daily trading volume of stock *i* at time *t*, $UE^*Size_{i,t}$ captures the market capitalization of firm *i* at time *t*. $UE^*StdDev_{i,t}$ represents daily return volatility of firm *i* at time period *t*. $UE^*Price_{i,t}$, is stock *i*'s daily closing price. $UE^*Spread_{i,t}$ is the relative spread of firm *i* at time *t*. Two tailed tests of significance are reported as follows, *** denotes significance at 1%, ** denotes significance at 5% and * denotes significance at 10%.

Panel A: mid-point return

	PEAD3		**PEAD5**		**PEAD(+1,10)**		**PEAD(+1,30)**		**PEAD(+1,60)**	
	Coef.	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
C	2.355	12.94***	2.044	11.08***	1.967	9.34***	1.744	8.49***	2.013	10.24***
UE	0.010	0.74	0.014	0.84	0.368	3.21**	0.369	4.04***	0.361	3.46***
UE*OF	-0.011	-1.03	-0.009	-0.57	-0.373	-3.67***	-0.365	-3.97***	-0.375	-3.91***
UE*Vol	-0.597	-6.32***	-0.576	-4.86***	-0.193	-2.36**	-0.209	-2.28**	-0.194	-2.00*
UE*Size	0.019	1.06	0.016	0.99	0.029	0.64	0.031	0.60	0.033	0.61
UE*StdDev.	-0.411	-4.98***	-0.406	-4.00***	-0.307	-3.04**	-0.288	-2.89**	-0.293	-3.01**
UE*Price	0.137	1.82*	0.134	1.70*	0.172	1.95*	0.174	1.65*	0.171	1.72*
UE*Spread	-0.204	-2.93**	-0.208	-2.97**	-0.309	-3.10**	-0.300	-3.13**	-0.310	-3.17**

Panel B: closing price return

	PEAD3		**PEAD5**		**PEAD(+1,10)**		**PEAD(+1,30)**		**PEAD(+1,60)**	
	Coef.	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
C	4.064	16.30***	3.287	14.98***	2.645	13.06***	3.022	13.89***	3.118	14.02***
UE	0.006	0.67	0.010	0.96	0.329	3.97***	0.322	4.14***	0.382	4.11***
UE*OF	-0.001	-0.48	-0.000	-0.24	-0.309	-3.85***	-0.321	-4.03***	-0.317	-4.02***
UE*Vol	-0.344	-4.01***	-0.323	-4.18***	-0.198	-2.30**	-0.207	-3.00**	-0.191	-2.63**
UE*Size	0.016	1.03	0.017	1.04	0.022	0.63	0.027	0.61	0.032	0.62
UE*StdDev	-0.372	-4.67***	-0.366	-4.43***	-0.294	-3.31***	-0.298	-3.53***	-0.266	-3.17**
UE*Price	0.129	1.64*	0.131	1.69*	0.126	1.77*	0.151	1.81*	0.149	1.67*
UE*Spread	-0.122	-1.49	-0.116	-1.46	-0.241	-2.98**	-0.232	-3.16**	-0.232	-3.03**

Table 12. Alternatively defined UE measures: Regression between PEAD and firm variables by quote price effects： Negative earnings announcements

Table 12 represents the results of earnings response coefficient regressions to examine PEAD and order flow ratio for earnings surprises of firms listed on the FTSE350 trading on their earnings announcement days for the period January 2000 to December 2021, using the following pooled regression model:

$PEAD_{i,t}=\beta_0+\beta_1 UE_{i,t}+\beta_2\ UE^*OF_{i,t}+\beta_3\ UE^*Vol_{i,t}+\beta_4\ UE^*Size_{i,t}+\beta_5\ UE^*StdDev_{i,t}+\beta_6\ UE^*Price_{i,t}+\beta_7\ UE^*Spread_{i,t}+\varepsilon_t.$

$PEAD^m_{i,t}=\beta_0+\beta_1 UE_{i,t}+\beta_2\ UE^*OF_{i,t}+\beta_3\ UE^*Vol_{i,t}+\beta_4\ UE^*Size_{i,t}+\beta_5\ UE^*StdDev_{i,t}+\beta_6\ UE^*Price_{i,t}+\beta_7\ UE^*Spread_{i,t}+\varepsilon_t.$

$PEAD_{i,t}$ represents either *PEAD3*, *PEAD5, PEAD10,PEAD30* or *PEAD60*, for stock *i* in time period *t*. $PEAD^m_{i,t}$ represents the various *PEAD* measured by mid-point price. Independent variables include *UE*, which is the earnings surprise measured using the analyst forecast error method. *UE*OF* is the order flow ratio of firm *i* at time *t*. $UE^*Vol_{i,t}$, is the daily trading volume of stock *i* at time *t*, $UE^*Size_{i,t}$ captures the market capitalization of firm *i* at time *t*. $UE^*StdDev_{i,t}$ represents daily return volatility of firm *i* at time period *t*. $UE^*Price_{i,t}$, is stock *i*'s daily closing price. $UE^*Spread_{i,t}$ is the relative spread of firm *i* at time *t*. Two tailed tests of significance are reported as follows, *** denotes significance at 1%, ** denotes significance at 5% and * denotes significance at 10%.

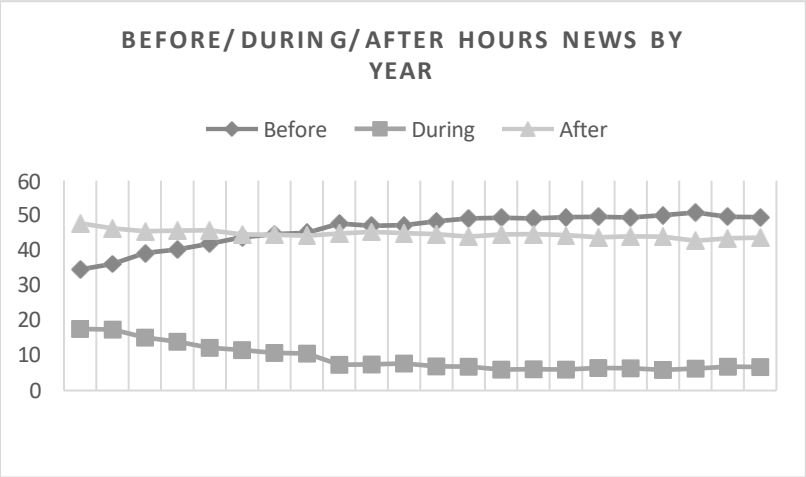
Panel A: mid-point return

	PEAD3		**PEAD5**		**PEAD(+1,10)**		**PEAD(+1,30)**		**PEAD(+1,60)**	
	Coef.	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
C	-3.645	-13.68***	-2.999	-14.09***	-4.004	-14.71***	-3.018	-12.84***	-2.848	-11.63***
UE	0.014	0.99	0.006	0.77	0.542	6.08***	0.539	5.97***	0.538	6.13***
UE*OF	0.013	0.96	0.009	0.82	0.443	4.90***	0.440	5.02***	0.432	5.11***
UE*Vol	-0.574	-6.21***	-0.632	-7.08***	-0.236	-3.72***	-0.207	-2.69**	-0.177	-2.88**
UE*Size	0.019	1.02	0.017	1.00	0.023	1.05	0.030	1.00	0.031	1.07
UE*StdDev.	-0.569	-6.02***	-0.527	-6.05***	-0.406	-4.19***	-0.318	-3.84***	-0.329	-4.84***
UE*Price	0.101	1.43	0.106	1.48	0.097	1.44	0.100	1.42	0.101	1.35
UE*Spread	0.246	2.90**	0.221	3.06**	0.422	4.37***	0.439	4.96***	0.423	5.01***

Panel B: closing price return

	PEAD3		**PEAD5**		**PEAD(+1,10)**		**PEAD(+1,30)**		**PEAD(+1,60)**	
	Coef.	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**	**Coef.**	**T-stat**
C	-2.479	-10.06***	-1.738	-8.28***	-2.144	-9.65***	-2.625	-11.77***	-2.011	-9.02***
UE	0.002	0.36	0.005	0.51	0.436	5.00***	0.429	5.97***	0.421	5.01***
UE*OF	0.009	0.90	0.007	0.89	0.338	4.19***	0.337	4.81***	0.340	4.06***
UE*Vol	-0.516	-5.98***	-0.509	-5.85***	-0.165	-2.20*	-0.129	-2.08*	-0.123	-2.16*
UE*Size	0.013	0.97	0.011	0.92	0.021	1.04	0.027	1.00	0.029	0.93
UE*StdDev	-0.399	-4.16***	-0.401	-4.77***	-0.386	-4.36***	-0.280	-3.40***	-0.298	-3.45***
UE*Price	0.103	1.44	0.097	1.36	0.095	1.38	0.086	1.37	0.090	1.16
UE*Spread	0.196	2.73**	0.200	2.99**	0.291	3.16**	0.264	3.24**	0.285	3.03**

Panel A: Before/During/After hours news by year



Panel B: Earnings news by weekdays

Fig. 1. Earnings Announcements Times and Days Information

Panel A presents the percentage of earning announcements that occur throughout the day. Panel B presents the percentage of earning announcement by day of week.