Local investor attention and post-earnings announcement drift

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Abstract

We show that local investor attention, as a proxy for the arrival rate of informed trading, has an impact on post-earnings announcement drift. Measured by monthly abnormal Google search volume before the earnings announcement, high (low) local investor attention is associated with weak (strong) delayed market reaction to the earnings announcement and strong (weak) abnormal trading volume in the pre-earnings announcement period. The evidence documented in this paper supports both ‘‘rational structural uncertainty’’ and attention allocation theories that argue that information distribution among investors plays an important role in explaining market anomalies.

Keywords Local attention · Google search · Geographic proximity · Information advantages · Post-earnings announcement drift

JEL Classification G14 · D82 · M41

1. Introduction

Do investors have better access to value-relevant information of local firms? Does attention to local stocks help market to have more informed trading? While literature is inconclusive about whether local investors have information advantages or not, little has been done on how local activity of information acquisition might affect the market efficiency. This paper addresses this issue by examining the relationship between local investor attention and the phenomenon of post-earnings announcement drift (hereafter PEAD).

Since it was first documented in the late 1960s (Ball and Brown 1968), the PEAD or the delayed market reaction to earnings announcements has attracted substantial attention from finance and accounting researchers (e.g., Bernard and Thomas 1990; Bhushan 1994; Bernard and Seyhun 1997; Chordia and Shivakumar 2006; Bird et al. 2014). Fama (1998) acknowledges that PEAD is one of two robust and persistent anomalies that challenge the efficient markets paradigm.

Two competing theories to explain this market anomaly are the ‘‘behavioral’’ theory (Daniel et al. 1998) and the ‘‘rational structural uncertainty’’ theory (Brav and Heaton 2002). The ‘‘behavioral’’ theory posits that PEAD is attributed to the distinction between public and private information in that investors underreact (overreact) to public (private) information. In contrast, the ‘‘rational structural uncertainty’’ theory predicts that the distribution of information plays an important role in explaining PEAD, which leads to the argument that a high arrival rate of informed traders reduces structural uncertainty and hence weakens PEAD.

Even though literature is rich in providing empirical evidence (e.g., Chan 2003; Del- laVigna and Pollet 2009; Hirshleifer et al. 2009) supporting the ‘‘behavioral’’ theory, the evidence regarding the role of information distribution in explaining the PEAD is relatively scarce. In this paper, we provide direct evidence in support of the ‘‘rational structural uncertainty’’ theory. Using local investor attention as a proxy for the arrival rate of informed traders, we document that stocks with high local investor attention are associated with weak PEAD.

Local investors could have access to information sources that are specific to geographical proximity as well as have opportunities to gather knowledge of tangible and intangible characteristics surrounding the operational activities of a firm. To capitalize their exclusive information advantages, as research on attention allocation theory (e.g., Van Nieuwerburgh and Veldkamp 2009) suggests, investors tend to allocate more attention to local stocks that might make their decision of asset holdings biased toward local companies. The attention allocation theory further argue that it is optimal for investors to search and process more public information about local firms when they receive private information. Thus, we propose to use local investor attention as a reasonable proxy for the arrival rate of informed trading following two reasons: first, high local attention implies that there is a high arrival rate of private information that causes informed trading; second, it also implies that local investors are active in learning of a stock and verifying private information to complement public information. Both of these effects will accelerate the arrival rate of informed traders.

Following Da et al. (2011), we use aggregate search frequency in Google as a direct measure of investor attention. The attention variables are constructed using abnormal Google search volume. We collect monthly search volume index (SVI) data for each stock ticker symbol of S&P 500 firms from Google Insight for Search that allows us to differentiate the search locations at the state and country levels. Local

attention variables are constructed using state level abnormal SVI, whereas country level abnormal SVI is utilized for constructing national attention variables. The abnormal SVI is defined as the natural logarithm of SVI in the current month minus the median value of the natural logarithm of SVI over the previous 3 months.

One shortcoming is that we have to depend on a calendar monthly, neither daily nor weekly, basis of SVI data to develop our measure of local attention. Lack of daily or weekly data could lead us to lose a part of search activities information coming from the time-frame right before the announcement day.[1] For example, if the earnings announcement of the firm is on 07/21/2009, the information available to construct the attention variables before the earnings announcement is the SVI in the previous calendar month, i.e. in June, 2009. Therefore, local attention prior to the earnings announcement is measured with error, especially for the announcements made toward the end of a month, which have longer time interval between the announcement date in month t and the end of calendar month t - 1. To overcome this limitation, our main sample consists of announcements made in the first half of each calendar month.[2]

We perform quarterly decile or quintile sorts by each firm's earnings surprise, and by each firm's level of attention received from the investors prior to the earnings announcement. We then examine the impact of investor attention on the delayed market response to earnings announcements in a multivariate context. Consistent with our pre- dictions, local investor attention prior to earnings announcements, which proxies for the arrival rate of informed trading, has a negative impact on the delayed market reaction to earnings news. Furthermore, such PEAD-weakening effect of local attention is predominantly present for the announcing firms that are headquartered in states with smaller population, and for the firms that experience lower number of same day announcements. We perform several robustness tests and the results reconfirm our main finding that there is a negative relation between local attention and PEAD.

The extent to which investors react to earnings news can also be measured by the way trading volume responds to earnings announcements. Accordingly, we also perform tests on the relation between abnormal trading volume and investor attention pre- and post- earnings announcement. The results show that local investor attention is positively related with abnormal trading volume during the pre-earnings announcement period. However, we also find that high pre-announcement local investor attention is associated with low abnormal trading volume in the post-earnings announcement period. These findings are consistent with the notion that local investor attention indeed proxies the arrival rate of informed traders.

This paper contributes to the literature in several ways. First, our findings provide support for the theory of ''rational structural uncertainty''. Following the argument of the theory, as the distribution of information plays an important role in the economy, the arrival rate of informed traders should be negatively associated with structural uncertainty and thereby it would subside PEAD. We provide

[1] Previous papers that apply daily or weekly SVI data, such as the papers of Da et al. (2011) and Drake et al. (2012) using weekly and daily SVI data, respectively, are focused on aggregate level of attention. For queries at local or state level, Google provides a breakdown of its data by month, not by week or day. Under this condition, we can only construct valid measure for local attention in the calendar month before earnings announcement.

[2] We also construct an alternative sample that includes earnings announcements that are made no less than 10 calendar days before the end of the announcement month. Our results still hold for this alternative sample. Results are available upon request.

empirical evidence that the arrival rate of informed traders, proxied by local attention, is inversely related with PEAD. Second, our evidence also favors the theory of attention allocation, as the finding of local attention's ability of weakening PEAD supports the argument that local investors motivated by the arrival of private information allocate more attention to local stocks.

Finally, it also contributes to the ongoing debate on whether local individual investors have value-relevant information advantages due to the geographical proximity to investment opportunities (e.g., Ivkovic and Weisbenner 2005; Seasholes and Zhu 2010; Giannini et al. 2015).[3, 4] We argue that local investors' information acquisition activities, which could be initiated with the gain of private information, are highly likely to be associated with informed trading in the market. The evidence that local investor attention, as opposed to national investor attention, has an impact on future stock returns indicates that the geographical proximity to investment opportunities facilitates value-relevant information advantages for the local investors.

The remainder of the paper is organized as follows. Section 2 provides a discussion on the theoretical background and prior literature motivating our hypothesis, Sect. 3 provides discussion on the sample and the findings from descriptive statistics. Section 4 discusses the findings from empirical analyses and Sect. 5 provides tests for sensitivity analyses. Section 6'' provides concluding remarks.

2. Literature review and hypothesis development

2.1. Local individual investors: informed or behaviorally biased?

Coval and Moskowitz (1998) introduce the ''home bias puzzle'', a phenomenon which is supported by a large body of literature showing that investors prefer domestic assets in their international investment, into the context of domestic investment to observe whether investors also show a bias for local assets. Their evidence confirms the existence of a ''local bias puzzle'', which might be the result of informational gap between local and nonlocal investors as they argue. Since their work, we can observe a growing body of studies dealing with the questions of to what extent and why such bias exists. While this line of literature is consistent in confirming evidence of local bias, (e.g., Ivkovic and Weisbenner 2005; Seasholes and Zhu 2010), the issue that is not yet settled is why investors favor local stocks. The two alternative explanations for local preference have been offered in prior work are information advantages and behavioral bias.

Papers that argue for information advantages claim that investors prefer local stocks because they are better informed about local companies. There are multiple sources from which local investors could receive more information, such as from private contacts with local firms and social networks of other

[3] Ivkovic and Weisbenner (2005) find that the average household can generate an additional annualized return of 3.2% from its local investment relative to nonlocal holdings, and posit that local bias stems from the information advantage of local firms over nonlocal firms instead of from simple familiarity. However, Seasholes and Zhu (2010), using two types of calendar-time portfolios based on holdings and transactions, find that portfolios of local investment do not generate abnormal returns relative to their nonlocal holdings and conclude that individual investors do not appear to have value-relevant information advantages on their local investments.

[4] While previous studies on individual investors typically use a small set of individual investors from a number of brokerage firms, Wang and Zhang (2015) use a comprehensive dataset covering individual investors on NYSE and find that individual trading improves stock market informativeness.

investors (Feng and Seasholes 2004); Hong et al. 2004), or from information going viral by word of mouth (Hong et al. 2005). Geographical proximity to a firm aids in understanding the operational know-hows of a firm, and makes it less expensive to gain knowledge of intangible aspects such as management quality and corporate practices of business transactions (Gaspar and Massa 2007). Essentially the opportunities of acquiring soft or unquantifiable information of a firm, which greatly depends on geographical proximity between insiders and outsiders (Gertler 2003), and knowledge of local business climate are likely to be more available to local investors than nonlocal investors. If the investors favor local stocks because of their information advantages, then we could expect to find that local investors would earn a higher superior return than nonlocal investors. Confirming this prediction, Ivkovic and Weisbenner (2005) show that local holdings of individual investors are associated with 3.2% annual abnormal returns compared to nonlocal holdings. There are other influential studies, such as of Feng and Seasholes (2004), Massa and Simonov (2006), Bodnaruk (2009), Shive (2012), Peress (2014), which provide evidence that supports information based trading behavior of local investors.

The other explanation for local preferences is behavioral biases, which is based on the belief that investors prefer local stocks because they are more familiar with the assets of local companies. Essentially while attention is scarce as a cognitive resource, investors with limited attention tend to use mental shortcuts, such as focusing on companies that attract their recent attention, in searching for stocks for trading (Odean 1999; Barber and Odean 2008). Thus, bias for local stocks could be a consequence of behavioral or familiarity bias. This argument has empirical support. For example, both Huberman (2001) and Grinblatt and Keloharju (2001) provide evidence suggesting that it is mainly the behavioral bias that lead the investors to hold local stocks in a greater proportion.[5] Furthermore, bias of investor sentiment could vary across the stocks, creating differential market returns that are driven by behavioral bias (Li and Yeh 2011). If local investors are simply influenced by familiarity bias, then their investment should not generate any superior returns. In an influential empirical study, Seasholes and Zhu (2010) find that investors do not earn any abnormal returns from their holdings of local stocks.

2.2. Local search activity: proxy for arrival of informed trading

Apart from the debate of whether information advantage or familiarity bias leads to the local bias, information acquisition activity of local investors, which is the focus of our study, could play itself an important role in local informed trading. In other words, even though local investors' trading decisions might be driven by familiarity bias, as argued by a number of studies (e.g., Seasholes and Zhu 2010), it does not necessarily undermine the importance of local information acquisition activity as a potential source of informed trading. Essentially, for example, an investor could decide to pay attention to a local stock because of behavioral bias, but such biased driven decision could lead to the exploitation of local advantages in information and subsequent further information acquisition activity, all of which could increase the odds of informed trading. A key point here is that no matter whether an investor pays attention

[5] In a recent study, Wu and Gau (2017) argue that domestic investors who are partially informed are also likely to be overconfident and therefore, they could overreact to new information of domestic stocks, which would result in a home bias.

to a local stock because of information advantages or familiarity bias, it is the local investors' information acquisition or search activity that could place them in an advantageous position over nonlocal investors.

According to attention allocation theory, as the model of Van Nieuwerburgh and Veldkamp (2009) suggests, investors tend to utilize their informational advantage on local firms by focusing more on local stocks. If investors receive any information from local private source, they might tend to verify their information by engaging more in search activity. Prior literature uses Google searches for a firm's ticker symbol as a measure of the extent at which a firm receives attention from investors (e.g., Da et al. 2011; Drake et al. 2012). Searching online by a ticker symbol supplies information in a variety of forms such as links to major investment tools; financial reports and experts' opinions, analytical comments and blog posts, and press releases. These sources of information could help local investors verify their knowledge about local firms and lead to a subsequent informed trading. Nevertheless, as making of an impact on the market requires investors' attention to the public information (DellaVigna and Pollet 2009; Hirshleifer et al. 2009)[6], local investors' search activity is more likely to amplify their knowledge advantages over nonlocal investors.

Overall the local investors, equipped with local informational advantage, should have an incentive to acquire more information that could play an important role in the market. For example, examining how friction in information flow to local investors affects the search activity and consequential market activity of local stocks, Brown et al. (2015) show the importance of local search activities for the market efficiency. Their evidence suggests that local investors are informed and they are important for liquidity and price discovery.

The importance of local search activity motivates us to observe how such information acquisition might play role in mitigating the phenomenon of PEAD. That is rather than information associated with earning announcements immediately being reflected into the market prices, there is a tendency of security prices to drift for a period following the direction of earnings surprises. Vega (2006) finds that public or private information which is associated with the high arrival rate of informed traders mitigates the drift. Also, the timing of information arriving will influence the market reactions (Sharathchandra and Thompson 1994; Eden and Loewenstein 1999). Their finding supports the ''rational structural uncertainty'' theory of Brav and Heaton (2002), which predicts a negative association between the arrival rate of informed traders and the structural uncertainty. In an empirical work that studies the relation between information distribution in the economy and market response to earnings announcements, using state-level data of Goodge search activities of stocks, Chi and Shanthikumar (2014) find that higher geographic dispersion of Google search of stocks is associated with weaker PEAD. Their evidence indicates the importance of information diffusion through local networks, which local investors initiate through exploiting their information advantages and subsequent sharing of knowledge within their own networks.

Based on the discussion above, both theories of ''attention allocation'' and ''rational structural uncertainty'' suggest that local attention is likely to be driven by local advantages in information that could lead to informed trading. As local attention has the features of capturing both information advantages and informed trading of local investors, in the presence of these characteristics, local

[6] In an empirical study, Hur and Singh (2016) find that investors' poor attention to a stock because of its low visibility could cause delayed market reaction to firm specific information.

information acquisition activity should alleviate the drift in market. Thus, we hypothesize that local attention would be negatively associated with PEAD.

3. Sample data and descriptive statistics

We utilize five sources of data to construct our sample: data to create our attention variables are from Google Insights for Search; stock returns, prices, and volume related variables are from CRSP; accounting data and information of the location of firm head- quarters are from Compustat; data to construct earnings surprises are from I/B/E/S; data to measure institutional ownership are from Thomson-Reuters 13F institutional holdings. As information of investor attention at local level is available on a calendar month basis, our attention variables are applied to the SVI data of the month immediately preceding earnings announcement dates. It might create measurement error in the variables of attention, especially if an announcement takes place toward the end of a month and consequently the time interval between the announcement date of the month t and the end of the previous month t - 1 becomes longer. To partially alleviate this problem, our main sample is constructed by excluding earnings announcements made less than 15 calendar days before the end of the announcement month t.[7] We also delete observations for which we lack information on any of the control variables. Our final sample contains 3395 observations from 2004 to 2010.

3.1. Attention variables

The fact that Google Insights for Search provides search volume data at the state level allows us to construct the local attention variable.[8] We restrict our sample to S&P 500 firms that are headquartered in the United States.[9] To eliminate survivorship bias and the impact of index addition and deletion (e.g., Denis et al. 2003; Chen et al. 2006), our sample consists of all stocks ever included in the index during our sampling period that spans the months from January 2004 to December 2010. We collect monthly SVI data for individual stocks by searching its ticker. Searching a stock using its ticker is more likely to reflect investors' interest in financial information about the stock than using the firm name (e.g., Da et al. 2011). We then select the ''compare by location'' option to download monthly SVI data at two levels: national SVI by selecting ''United States'' as the target country and local SVI by selecting the same country with specifying the state where the firm is headquartered in the subregion option (see Fig. 1). In this way, monthly national and local searches' information obtained simultaneously for a given ticker ensures the compatibility of the attention variables. Google Insights for Search provides zero values of SVI for some our queries that have of low popularity. Accordingly, we delete observations with zero value for a ticker's SVI. National (local) attention is measured as the abnormal SVI to the company's ticker filtered by country

[7] Since attention variable should lose much of its efficacy when there is a large interval between the reporting data of SVI index and the date of earnings announcement, we expect to observe a much weaker effect of local attention on PEAD when we use announcements made in the latter half of the month. See our further discussion on this issue in Sect. 5.1.

[8] http://www.google.com/insights/search/.

[9] We focus on S&P 500 firms because Google Insights for Search applies some minimum thresholds for inclusion in the tool and provides results mainly for searches that exhibit a significant amount of volume.

(state). Abnormal SVI is defined as the logarithm of SVI during the current month minus the logarithm of the median value of SVI over the previous 3 months.

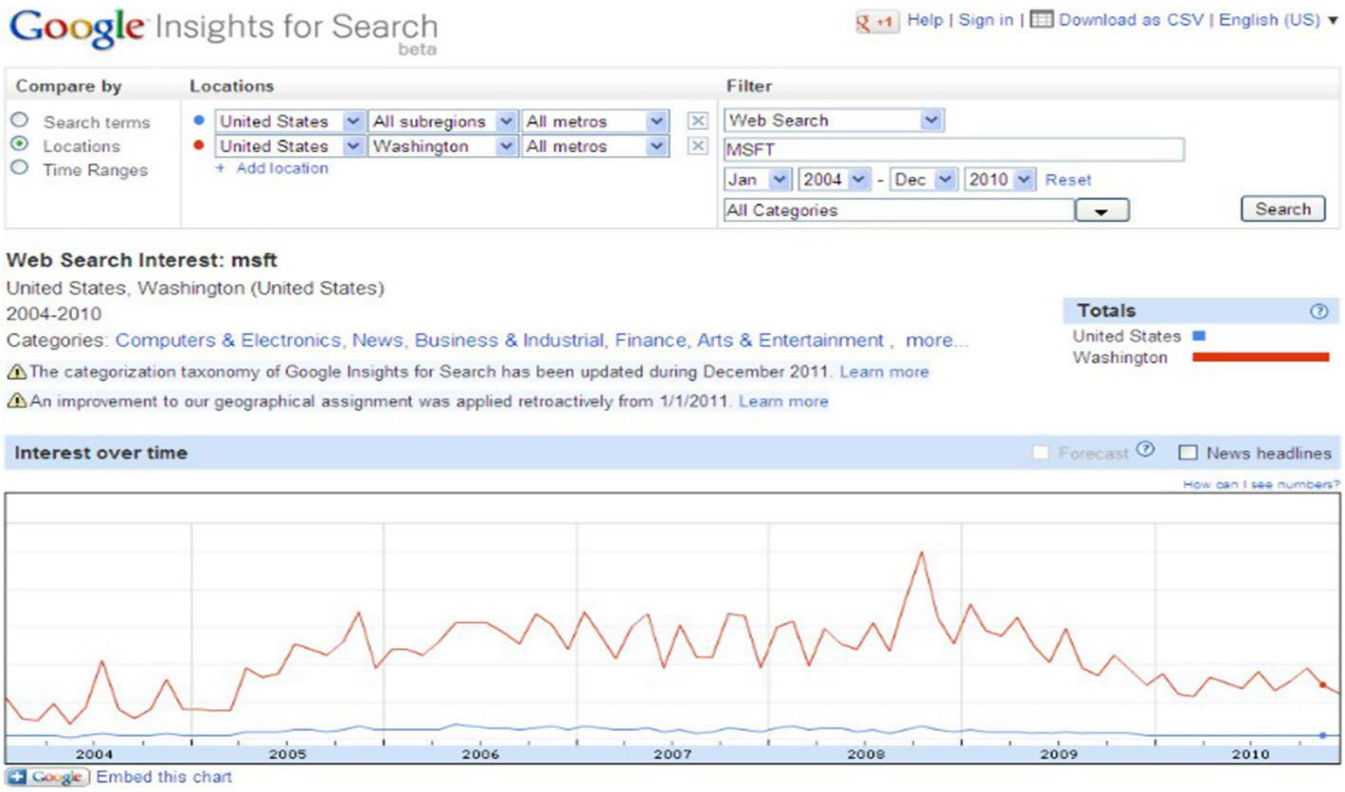

Fig. 1 Example of Local and National Search Volume Index for Microsoft' Ticker (MSFT) from 2004 to 2010. The red (blue) line in the chart denotes the local (national) SVI trend from 2004 to 2010. We extract monthly data from the above chart. It is noticeable that in this case, local SVI fluctuates frequently as oppose to national SVI, meaning local investor attention changes more than national investor attention. This figure is a screenshot of Google Insights for Search (Color figure online)

3.2. Earnings surprises

Quarterly earnings announcements for S&P 500 firms are from I/B/E/S. To estimate the forecast error as a measure of earnings surprise, we calculate the difference between actual earnings per share and the most recent analyst forecast. Following Kothari (2001) and DellaVigna and Pollet (2009), we then normalize the difference by the stock price five trading days before the earnings announcement as the measure of earning surprises. Let $AE_{t;k}$ be the actual earnings per share announced in quarter t for company k and $FE_{t;k}$ be the corresponding most recent analyst forecast. The stock price of company k five trading days before the announcement in quarter t is denoted by $P_{t;k}$. The earnings surprise $ES_{t;k}$ is

$$ES_{t,k} = \frac{AE_{t,k} - FE_{t,k}}{Pt,k}$$

Earnings, forecasts and stock prices are all split-adjusted.

3.3. Cumulative abnormal returns

The cumulative abnormal returns over the post-announcement window [2, 51] are defined as the difference between the buy-and-hold returns of announcing firms and that of a size and book-to-market (B/M) matching portfolio over the window [2, 51] in trading days relative to the announcement date.[10] We use Fama–French 25 size and B/M portfolio returns as the benchmark return. Each stock is matched with one of the 25 benchmark portfolios at the end of June based on market value at the corresponding point of time and the book equity of the last fiscal year-end in year t - 1 divided by the market value at the end of December of year t - 1,

$$BHAR[2,51]_{jp} = \sum_{i=t+2}^{t=51} (1 + R_{ji}) - \sum_{i=t+2}^{t=51} (1 + R_{pi})$$

where R_{ji} is the daily return of firm j and R_{pi} is the daily return of the matching size-B/M portfolio on day i, where t is the announcement date of quarter q's earnings.

We focus primarily on a 50 trading days' post-announcement window for two reasons. First, the evidence documented in the literature (e.g., Bernard and Thomas 1989) shows that most of the drift occurs during the first 60 trading days after the announcement. Second, the magnitude and longevity of PEAD are negatively related with firm size. Therefore, given the fact that our sample is comprised of S&P 500 firms, we deem that it is reasonable to examine the cumulative abnormal returns over 50 trading days in the post-announcement period. However, to investigate how local attention effects evolve, we also conduct several tests with different horizons ranging from 31 to 75 trading days in the next section.

3.4. Other control variables

Other standard control variables are constructed using CRSP and Compustat information. Institutional ownership data is extracted from Thomson-Reuters Institutional Holdings (13F) Database. Data to calculate analyst responsiveness is collected from I/B/E/S. Detailed variable definitions can be found in ''Appendix''.

3.5. Descriptive statistics

Table 1 Panel A reports descriptive statistics for the key variables that have been used in our analysis. The results for attention variables are comparable to the findings in Mondria and Wu (2013). The mean value of local attention (LASVI) is - 0.0103, and of national attention (NASVI) is - 0.0047. Median values of both local and national attention are zero, which are not unusual as attention variables in our analysis are abnormal attention calculated as the log of monthly national (local) SVI minus the median log value of

[10] Barber and Lyon (1997) and Daniel and Titman (1997) suggest that matching sample firms to firms of similar sizes and book-to-market (BM) ratios, rather than using factor betas to measure cumulative abnormal returns, yields better-specified test statistics. However, to make sure the results are robust, abnormal returns calculated by market model are used.

national (local) SVI in the previous 3 months. Values of standard deviation show that stocks experience larger variation in attention from local acquirers than national acquirers of information. Both bottom and top quartile values of local and national attention suggest that local search activities tend to experience more extreme movements in both tail of its distribution than national search activities. The descriptive statistics of other control variables are comparable to those in Drake et al. (2012) whose sample was composed of S&P 500 firms from 2005 to 2008.

Table 1 Sample descriptive statistics

	N	Mean	SD	Q1	Median	Q3
Local attention	3395	− 0.0103	0.2425	− 0.1263	0.0000	0.1065
National attention	3395	− 0.0047	0.1915	− 0.0780	0.0000	0.0667
Earnings surprise	3395	0.0071	0.0387	0.0004	0.0011	0.0031
Size ($M)	3395	22,792	41,036	4707	9822	21,772
B/M	3395	0.5797	0.9061	0.2540	0.4153	0.6644
Reporting lag	3395	27.4900	11.9400	21.0000	26.0000	32.0000
# Analysts	3395	19.4000	8.8646	13.0000	19.0000	24.0000
Turnover	3395	0.2551	0.2005	0.1264	0.1972	0.3192
Earnings volatility	3395	0.3385	1.6441	0.0993	0.1697	0.3131
Earnings persistence	3395	0.5112	0.4643	0.2210	0.5907	0.8328
Institutional ownership	3395	0.7238	0.2134	0.6323	0.7593	0.8520
# Announcements	3395	156.2300	101.5500	71.0000	137.0000	239.0000
Analyst responsiveness	3395	0.0715	0.2577	0.0000	0.0000	0.0000

This table reports the summary statistics for variables from 1994 to 2010. See ‘‘Appendix’’ for variable definitions and descriptions

4. Empirical results

We start our investigation with multivariate tests using the sample that includes all earnings surprises. To circumvent potential problems caused by sample outliers and nonlinearity in the relation between abnormal returns and earnings surprises (e.g., Kothari 2001), we use the decile/quintile rank of earnings surprises rather than the actual values of earnings surprises.

4.1. Baseline results: local attention and PEAD

To control for other confounding factors, we employ a model wherein we regress 51-day post-announcement abnormal returns (BHAR [2, 51]) on the variable capturing the rank of earnings surprises (DES/QES), the investor attention (local, or national) rank variable (DLRANK, or DNRANK and QLRANK, or QNRANK) and their interactions. Specifically, we interact DES (QES) with DLRANK (QLRANK), or DNRANK (QNRANK) and other control variables as shown below[11]:

[11] The models shown below are those for decile ranks. The corresponding quintile ranks models are not shown for brevity.

$$BHAR = \gamma_0 + \gamma_1 DES + \gamma_2 DLRANK + \gamma_3 (DES \times DLRANK) + \Sigma \varphi i Xi + \Sigma \delta i (DES + Xi) + \varepsilon$$

$$BHAR = \gamma'_0 + \gamma'_1 DES + \gamma'_2 DLRANK + \gamma'_3 (DES \times DLRANK) + \gamma'_4 (DES \times DNRANK) + \gamma'_5 DNRANK + \Sigma \varphi'_i Xi + \Sigma \delta'_i (DES + Xi) + \varepsilon$$

In these tests, we are interested in the coefficient of the interaction term (γ_3, γ'_3, and γ'_4) that tests whether the BHAR corresponding to deciles/quintiles of earnings surprises is significantly different across the local (national) attention deciles/quintiles. We hypothesize that γ_3 and γ'_3 should be negative, indicating that PEAD becomes weak when local investor attention is high. Each of these models is also estimated using quintiles of earnings surprises and investor attention. Following previous studies, we control for factors that can affect the post-announcement market reaction to earnings news, such as firm size, earnings persistence (Bernard and Thomas 1989), earnings volatility, book-to-market, number of announcements on a given day (Hirshleifer et al. 2009), number of analysts following (Brennan et al. 1993), reporting lag (Chambers and Penman 1984), and day of the week (DellaVigna and Pollet 2009).

Additionally, we also control for information related to institutional ownership. Bartov et al. (2000) find that institutional holdings have a negative impact on post-announcement abnormal returns. Later Ke and Ramalingegowda (2005) find that arbitrage in the post- announcement period by transient institutional investors contributes to the persistence of PEAD.[12] Therefore, to control for effects due to institutional investors' holdings before earnings announcement, we add institutional ownership prior to the earnings announcement into the regression. Finally following Zhang (2008), we control for analyst responsiveness as an indicator variable equals one if there is at least one revision for the forecast of next quarter within two trading days after the earnings announcement for current quarter. Model (4) also controls for national attention and its interaction with earnings surprise decile/quintile rank.

The regression results are reported in Table 2. Standard errors of regression coefficient estimates are adjusted for heteroskedasticity and clustering by the day of earnings announcement. In both Panels A (DES) and B (QES) in the model with other controls (column 2), the coefficient γ_3 (DES: - 0.0008/QES: - 0.0032) is negative and significant at the 5% level. Similar results are found in column 1 in the model that does not include control variables. Essentially the coefficient estimate γ_3 indicates that delayed market reactions are significantly more sensitive to high local investor attention than to low local investor attention. Stronger results are shown in columns 3 and 4 when national investor attention is controlled for as well. In column 4, γ'_3 is negative (DES: - 0.0013/QES: - 0.0048) and significant at the 1% level. It is important to note that coefficients of national attention rank are negative and have no statistical significance, which might be the result of national investors' lack of access to value-relevant information and more engagement in noise trading. It also reasserts the importance of local attention as an appropriate proxy of the arrival of informed trading, whereas national attention does contain little value in capturing information incorporation in the market. Thus, local investor attention, which proxies for the arrival rate

[12] In a study testing the relation between attentions through blog contents in the internet and trading behavior of investors, Hun et al. (2013) find that blog coverage of a stock is negatively associated with stock returns, whereas such negative relation is predominant for the stocks with low institutional ownership.

of informed traders, accelerates the information diffusion among investors, leading to a weakened delayed market response.

Overall two noteworthy findings from Table 2 are: (1) local investor attention have a significantly negative impact on PEAD at the conventional level of significance; and (2) national investor attention has no statistical significance in affecting PEAD. Next, based on subsample test, we examine the presence of heterogeneity in the strength of local attention effect across some important characteristic the firms could be exposed to.

Table 2 Delayed market response to earnings surprises: regression analysis

	(1)	(2)	(3)	(4)
Panel A: DES				
DES	0.0063***	0.0118	0.0036	0.0090
	(0.002)	(0.011)	(0.002)	(0.011)
DLRANK	0.0047**	0.0043*	0.0060**	0.0059**
	(0.002)	(0.002)	(0.003)	(0.003)
DLRANK 9 DES	− 0.0009**	− 0.0008**	− 0.0013***	− 0.0013***
	(0.000)	(0.000)	(0.000)	(0.000)
DNRANK			− 0.0027	− 0.0035
			(0.002)	(0.003)
DNRANK 9 DES			0.0009	0.0010
			(0.001)	(0.001)
Other controls, interacted with DES		X		X
Constant	0.0176	0.0008	0.0277	0.0150
	(0.039)	(0.085)	(0.040)	(0.082)
Observations	3395	3395	3395	3395
Adj. R-square	0.027	0.038	0.032	0.040
Panel B: QES				
QES	0.0132***	0.0219	0.0069	0.0159
	(0.005)	(0.022)	(0.005)	(0.022)
QLRANK	0.0102**	0.0092*	0.0135**	0.0127**
	(0.005)	(0.005)	(0.006)	(0.006)
QLRANK 9 QES	− 0.0035**	− 0.0032**	− 0.0050***	− 0.0048***
	(0.001)	(0.001)	(0.002)	(0.002)
QNRANK			− 0.0074	− 0.0079
			(0.005)	(0.006)
QNRANK 9 QES			0.0036	0.0030
			(0.002)	(0.002)
Other controls, interacted with QES		X		X
Constant	0.0151	− 0.0019	0.0287	0.0145
	(0.040)	(0.092)	(0.040)	(0.088)
Observations	3395	3395	3395	3395
Adj. R-square	0.027	0.038	0.033	0.040

This table reports the effects of attention variables on the relation between post-announcement returns and earnings surprises from January 2004 to December 2010. The dependent variable is the 50-day cumulative abnormal return (BHAR [2, 51]). For each firm-quarter, earnings surprise deciles (DES) and quintiles (QES) are formed based on the value of the earnings surprises in the previous quarter. DLRANK (DNRANK)/ QLRANK (QNRANK) are attention deciles/quintiles based on quarterly independent sorts by local attention (national attention) one calendar month before the earnings announcement month. Other control variables include size, book-to-market and # earnings

announcements deciles/quintiles, log (1 ? # analysts), analyst responsiveness, reporting lag, share turnover, earnings volatility, earnings persistence, institutional ownership and indicators for year, month, weekdays and Fama–French 10 industry classification. See the detailed variable definitions in ‘‘Appendix’’. All controls are interacted with earning surprise deciles DES/ earnings surprise quintiles QES. Standard errors adjusted for heteroskedasticity and clustering by the day of announcement are in parentheses

*, **, *** Statistical significance at 10, 5, 1% levels, respectively

Table 3 Delayed market response to earnings surprises: subsample test

	Small population states (1)	Large population states (2)	High-news days (3)	Low-news days (4)
Panel A: DES				
DES	0.0228	− 0.0096	0.0164	0.0146
	(0.019)	(0.010)	(0.016)	(0.018)
DLRANK	0.0064*	0.0031	0.0013	0.0094*
	(0.004)	(0.003)	(0.003)	(0.005)
DLRANK 9 DES	− 0.0014**	− 0.0005	− 0.0007	− 0.0016**
	(0.001)	(0.000)	(0.001)	(0.001)
DNRANK	− 0.0012	− 0.0024	− 0.0005	− 0.0076*
	(0.004)	(0.003)	(0.003)	(0.004)
DNRANK 9 DES	0.0005	0.0007	0.0005	0.0013
	(0.001)	(0.001)	(0.001)	(0.001)
Other controls, interacted with DES	X	X	X	X
Constant	− 0.0710	0.1625**	− 0.3060*	0.0348
	(0.134)	(0.068)	(0.181)	(0.133)
Observations	1740	1655	1678	1716
Adj. R-square	0.071	0.043	0.071	0.069
Panel B: QES				
QES	0.0394	− 0.0189	0.0361	0.0272
	(0.037)	(0.019)	(0.035)	(0.036)
QLRANK	0.0144*	0.0058	0.0066	0.0175*
	(0.008)	(0.006)	(0.007)	(0.010)
QLRANK 9 QES	− 0.0054**	− 0.0018	− 0.0036	− 0.0055**
	(0.002)	(0.002)	(0.002)	(0.002)
QNRANK	− 0.0046	− 0.0050	− 0.0047	− 0.0156*
	(0.009)	(0.007)	(0.007)	(0.009)
QNRANK 9 QES	0.0022	0.0029	0.0029	0.0048
	(0.003)	(0.002)	(0.002)	(0.003)
Other controls, interacted with QES	X	X	X	X
Constant	− 0.0687	0.1714**	− 0.3295*	0.0365
	(0.143)	(0.072)	(0.180)	(0.146)
Observations	1740	1655	1678	1716
Adj. R-square	0.068	0.042	0.068	0.066

This table reports the results from subsample based tests in showing the effects of attention variables on the relation between post-announcement returns and earnings surprises from January 2004 to December 2010. In columns (1) and (2), large and small population states

are classified based on the median value of state- level population data collected from U.S. census website. In columns (3) and (4), high- and low news days are classified by the median value of the number of other firms announcing quarterly earnings on the same day. The dependent variable is the 50-day cumulative abnormal return (BHAR [2, 51]). For each firm- quarter, earnings surprise deciles (DES) and quintiles (QES) are formed based on the value of the earnings surprises in the previous quarter. DLRANK (DNRANK)/QLRANK (QNRANK) are attention deciles/ quintiles based on quarterly independent sorts by local attention (national attention) one calendar month before the earnings announcement month. Other control variables include size, book-to-market and # earnings announcements deciles/quintiles, log (1 ? # analysts), analyst responsiveness, reporting lag, share turnover, earnings volatility, earnings persistence, institutional ownership and indicators for year, month, weekdays and Fama–French 10 industry classification. See the detailed variable definitions in ‘‘Appendix’’. All controls are interacted with earning surprise deciles DES/earnings surprise quintiles QES. Standard errors adjusted for heteroskedasticity and clustering by the day of announcement are in parentheses

*, **, *** Statistical significance at 10, 5, 1% levels, respectively

4.2. Variation in local attention effect: subsample tests

4.2.1. Small versus large population states

While we focus on local attention constructed at state level, there is no reason to believe that the effect of local attention on PEAD should be homogenous across states. Large variation in size across states could make the effectiveness of being a local investor in a state completely different from another state. For example, let us think about a company which is headquartered in a big state like Texas, more specifically in Houston (Southeast Texas). For this company, ‘‘local investors’’ might not be an appropriate term to use for investors from cities of West Texas, such as from Lubbock. Thus, we can predict that smaller states would show much stronger results than larger states. We test this prediction by running tests on subsamples based on population size at state level collected from U.S. census website.13[13] We measure size by population because of the concern of potential mismatch between the area and the population of a state. For example, a state could be very large but population could be much smaller and concentrated in a few areas.[14] Columns (1) and (2) of Table 3 show results. We use median value of population in the sample to classify large and small population states. In column (1), the coefficient of interaction term between DLRANK and DES is negative and statistically significant at 5% level, which suggests that local attention helps weaken PEAD mainly for the companies headquartered in smaller population states.

Table 4 Delayed market response to earnings surprises: counterfactual situation

	(1)
Panel A: DES	
DES	-0.0020
	(0.005)
DLRANK	0.0013
	(0.002)
DLRANK 9 DES	- 0.0004*
	0.000
DNRANK	- 0.0015
	(0.002)
DNRANK 9 DES	0.0005
	0.000

[13] http://www.census.gov/popest/data/intercensal/state/state2010.html.

[14] Appendix B provides a detail account of the list of firms located in different states and population figures of the corresponding states.

Other controls, interacted with DES	X
Constant	0.0410
	(0.035)
Observations	5016
R-square	0.040
Panel B: QES	
QES	- 0.0128
	(0.012)
QLRANK	0.0040
	(0.003)
QLRANK 9 QES	- 0.0019*
	(0.001)
QNRANK	- 0.0049
	(0.004)
QNRANK 9 QES	0.0021
	(0.002)
Other controls, interacted with QES	X
Constant	0.0703*
	(0.042)
Observations	5016
Adj. R-square	0.041

This table reports the effects of attention variables on the relation between post-announcement returns and earnings surprises from January 2004 to December 2010. The sample only includes earnings announcements made in the second half of each month. The dependent variable is the 50-day cumulative abnormal return (BHAR [2, 51]). For each firm-quarter, earnings surprise deciles (DES) and quintiles (QES) are formed based on the value of the earnings surprises in the previous quarter. DLRANK (DNRANK)/QLRANK (QNRANK) are attention deciles/quintiles based on quarterly independent sorts by local attention (national attention) one calendar month before the earnings announcement month. Other control variables include size, book-to-market and # earnings announcements deciles/quintiles, log (1 ? # analysts), analyst responsiveness, reporting lag, share turnover, earnings volatility, earnings persistence, institutional own- ership and indicators for year, month, weekdays and Fama–French 10 industry classification. See the detailed variable definitions in ‘‘Appendix’’. All controls are interacted with earning surprise deciles DES/ earnings surprise quintiles QES. Standard errors adjusted for heteroskedasticity and clustering by the day of announcement are in parentheses

*, **, *** Statistical significance at 10, 5, 1% levels, respectively

Table 5 Local investor attention and transient institutional ownership

	Transient IO (1)
LASVI	0.020**
	(2.32)
NASVI	- 0.008
	(- 1.13)
AES	- 0.114*
	(- 1.79)
Log (size)	- 0.033***
	(- 21.87)
B/M	- 0.022***
Log (1 + # announcements)	-0,000
	(-0,14)
Log (1 + reporting lag)	0,003
	(0,89)
Log (1 + # analyst)	0,030***
	(2.64)
Earnings volatility	0.006***
	(3.05)
Earnings persistence	0.010*
	(1.80)

Constant	0.848***
	(20.32)
Observations	3395
Adj. R-squared	0.261

This table reports the relation between local investor attention and transient institutional ownership. Transient institutional ownership is the ownership possessed by transient institutional investors for each firm-quarter. Transient institutional investors are defined as in Bushee (1998). Refer to ''Appendix'' for detailed variable definitions. Indicators for year, month, weekdays and Fama– French 10 industry classification are also controlled. Standard errors adjusted for heteroskedasticity and clustering by the day of announcement are in parentheses

*, **, *** Statistical significance at 10, 5, 1% levels, respectively

4.2.2. Investor distraction

Prior literature suggests that investors with cognitive limitation can easily be distracted by their exposure to irrelevant information, which in turn can lead to underreaction to relevant news and overreaction to irrelevant news (e.g., Simons and Levin 1997; Banerjee and Mullainathan 2008; Barber and Odean 2008). Hirshleifer et al. (2009) study this distraction effect, under ''investor distraction hypothesis'', by predicting that greater number of same day earnings announcements would create distraction for investors and thus lead to more underreaction in the market. They find a positive relationship between the degree of post- announcement drift and number of companies announced earnings on the same day.

If a large number of announcements make investors distracted, then it could lead to a weaker effect of local attention on PEAD. To test this prediction, we run regression on two subsamples, high-news days and low-news days, based on the median value of the number of earnings announcement made on the same day. The results are shown in columns (3) and (4) of Table 3. We can observe that the coefficient of the interaction between DLRANK (QLRANK) and DES (QES) is statistically significant for subsample of low-news days. It suggests that local attention is more effective when investors are less distracted by information overload.

Table 6 Robustness checks

	CAR (1)	Exclusion of tricky symbols (2)	Exclusion of NY & CA (3)
Panel A: DES			
DES	0.0088	0.0008	0.0131
	(0.009)	(0.0112)	(0.0143)
DLRANK	0.0059**	0.0057**	0.0040
	(0.003)	(0.0027)	(0.0031)
DLRANK 9 DES	− 0.0011**	− 0.0012***	− 0.0010**
	(0.000)	(0.0004)	(0.0005)
DNRANK	0.0005	− 0.0035	0.0005
	(0.002)	(0.0024)	(0.0030)
DNRANK 9 DES	0.0004	0.0010**	0.0004
	(0.000)	(0.0004)	(0.0005)

Other controls, interacted with DES	X	X	X
Constant	0.0445	0.1476*	− 0.0181
	(0.077)	(0.0844)	(0.1128)
Observations	3395	3090	2375
Adj. R-square	0.037	0.045	0.039
Panel B: QES			
QES	0.0187	− 0.0012	0.0226
	(0.018)	(0.0224)	(0.0279)
QLRANK	0.0135**	0.0136**	0.0106
	(0.006)	(0.0059)	(0.0067)
QLRANK 9 QES	− 0.0047**	− 0.0051***	− 0.0044**
	(0.002)	(0.0018)	(0.0020)
QNRANK	− 0.0004	− 0.0093*	− 0.0013
	(0.005)	(0.0054)	(0.0066)
QNRANK 9 QES	0.0016	0.0041**	0.0017
	(0.002)	(0.0017)	(0.0021)
Other controls, interacted with QES	X	X	X
Constant	0.0389	0.1578*	− 0.0133
	(0.079)	(0.0889)	(0.1159)
Observations	3395	3090	2375
Adj. R-square	0.037	0.045	0.039

This table reports results for robustness checks. In column (1), the dependent variable is 50-day cumulative abnormal return CAR [2, 51] defined as the sum of difference between return of announcing firm and that of a size and book-to-market (B/M) matching portfolio over the window. In column (2), we follow Da et al. (2011) and remove 63 ticker symbols with potential alternative meanings (e.g., ONE, CAT, JAVA, MAT and GPS). In column (3), we delete observations of firms headquartered in New York and California. For each firm-quarter, earnings surprise deciles (DES) and quintiles (QES) are formed based on the value of the earnings surprises in the previous quarter. DLRANK (DNRANK)/QLRANK (QNRANK) are attention deciles/quintiles based on quarterly independent sorts by local attention (national attention) one calendar month before the earnings announcement month. Other control variables include size, book-to-market and # earnings announcements deciles/quintiles, log (1 ? # analysts), analyst responsiveness, reporting lag, share turnover, earnings volatility, earnings persistence, institutional ownership and indicators for year, month, weekdays and Fama–French 10 industry classification. See the detailed variable definitions in ‘‘Appendix’’. All controls are interacted with earning surprise deciles DES/earnings surprise quintiles QES. Standard errors adjusted for heteroskedasticity and clustering by the day of announcement are in parentheses

*, **, *** Statistical significance at 10, 5, 1% levels, respectively

5. Robustness checks

In this section, we conduct several robustness checks to examine alternative explanations for the findings documented in this paper.

5.1. Local attention and PEAD: counterfactual situation

As we discussed earlier in the Sect. 3, the long interval between the end of the previous month t - 1 of which SVI data we use and the timing of announcement made in the current month t can create a measurement error in our measure of local attention. For this reason, our main sample consists of the announcements made in the first half of the month. On the other hand, we can predict that using earnings

news announced in the last half of the month should lead to a much weaker effect of local attention on PEAD.[15]

Nevertheless, from previous literature we can find strong support for the argument that announcements made earlier should be more effective in the context of magnitude of market reaction and generation of new information. In a recent work Savor and Wilson (2016) argue that both capacity of generating and demand for acquiring information are higher for early announcers than for late announcers. Their further argument indicates that early announcements should receive higher market reaction as it provides a greater scope of learning for investors. Moreover, evidence of prior studies suggests that information content of earnings news announced earlier is relatively new and much unanticipated that can be transferred to news revealed by late announcers. For example, Freeman and Tse (1992) find a positive information transfer between early and late announcements that take place within same industry. Later a number of studies confirm the presence of strong correlation between early and late announcements (e.g., Ramnath 2002; Thomas and Zhang 2008). Essentially this line of literature argues that information supplied by early announcements can help predict earnings news of late announcers, which makes the former more important in the process of information production and distribution in the market.

To test whether late announcements are associated with weak relationship between local attention and PEAD, we run tests based on the subsample of announcement made in the last half of the month. From the results shown in Table 4, we can observe that local investor attention lose much of its economic and statistical significance once we consider the announcements of the latter half of the month. For example, the coefficient estimate of the interaction term between local investor attention deciles and earnings surprises deciles, DLRANK 9 DES, is - 0.0004, as opposed to - 0.0013 in the baseline (Table 2 Column 4). Similar results we can observe when we use quintile ranking of attention in Table 4 Panel B.

Table 7 Persistence of local attention effect on PEAD

	[2, 31]	[2, 51]	[2, 75]
Panel A: DES			
DES	0.0062	0.0090	0.0041
	(0.009)	(0.011)	(0.009)
DLRANK	0.0051**	0.0059**	0.0031
	(0.002)	(0.003)	(0.002)
DLRANK 9 DES	− 0.0010***	− 0.0013***	− 0.0006
	(0.000)	(0.000)	(0.000)
Other controls, interacted with DES	X	X	X
Constant	0.0555	0.0150	− 0.0650
	(0.066)	(0.082)	(0.073)
Observations	3395	3395	3395
Adj. R-square	0.042	0.040	0.038
Panel B: QES			
	[2, 31]	[2, 51]	[2, 75]
QES	0.0126	0.0159	0.0071
	(0.017)	(0.022)	(0.018)

[15] A more detailed discussion on this issue can be found in Sect. 3.

QLRANK	0.0108**	0.0127**	0.0057
	(0.005)	(0.006)	(0.005)
QLRANK 9 QES	− 0.0037***	− 0.0048***	− 0.0022
	(0.001)	(0.002)	(0.002)
Other controls, interacted with QES	X	X	X
Constant	0.0528	0.0145	− 0.0623
	(0.070)	(0.088)	(0.078)
Observations	3395	3395	3395
Adj. R-square	0.041	0.040	0.036

This table reports the results about how fast is the impact on PEAD by information incorporation of local investors. We obtain PEAD over 31-, 51-, and 75-day horizons. The cumulative abnormal returns are defined as buy-and-hold return adjusted by size and book-to-market (B/M) over different post-announcement windows. For each firm-quarter, earnings surprise deciles (DES) and quintiles (QES) are formed based on the value of the earnings surprises in the previous quarter. DLRANK (DNRANK)/QLRANK (QNRANK) are attention deciles/quintiles based on quarterly independent sorts by local attention (national attention) one calendar month before the earnings announcement month. Other control variables include size, book-to-market and # earnings announcements deciles/quintiles, log (1 ? # analysts), analyst responsiveness, reporting lag, share turnover, earnings volatility, earnings persistence, institutional ownership and indicators for year, month, weekdays and Fama–French 10 industry classification. See the detailed variable definitions in ‘‘Appendix’’. All controls are interacted with earning surprise deciles DES/earnings surprise quintiles QES. Standard errors adjusted for heteroskedasticity and clustering by the day of announcement are in parentheses

*, **, *** Statistical significance at 10, 5, 1% levels, respectively

5.2. Local attention and transient investors

Note that we should cautiously interpret our results because we do not use any measures that can directly capture local investors' trading activities, structure of share ownership, or holding of private information. Limitation in accessing to such data leads us to depend on local attention as a proxy of informed trading. We try to address this issue by studying the relationship between ownership of transient investors and local attention.

Prior studies suggest that transient institutional investors employ active trading strategy (e.g., Bushee 1998; Brown and Hillegeist 2007), which is likely to be based on private information (e.g., Ke and Petroni 2004; Yan and Zhang 2009).[16] On the other hand, in this paper we argue that local investors, equipped with their advantages in accessing private information, utilize their knowledge gathered from information acquisition activities in trading around the earnings announcements. If local investor attention is driven by the arrival of private information which is also likely to be exploited by transient institutional investors, we should observe a positive relation between local investor attention and transient institutional ownership. We test this prediction in Table 5, where we follow Bushee (1998) to define a transient investor. We find a statistically significant positive relationship between LASVI and transient institutional ownership, which indicates the importance of local investor attention in understanding the role the local investors play for an informationally efficient market. Additionally, this finding provides another piece of evidence to mitigate the concern that Internet search-based local investor attention is merely a noise rather than information-related measure.

[16] Nonetheless, institutional investors are better at collecting and processing firm-specific information and can make stronger impact in the market (e.g., Kao 2007; Frijns et al. 2014).

5.3. Alternative measure of cumulative abnormal returns

In a further robustness check, we construct an alternative measure of cumulative abnormal returns by cumulating the difference between the return of the firm and that of a size and book-to-market (B/M) matching portfolio over the window [2, 51]. The results in column (1) of Table 6 indicate that our findings are not sensitive to the alternative measures of cumulative abnormal returns.

5.4 Measurement error of attention variables

Some tickers we use to search have a generic meaning such as ‘‘ONE’’, ‘‘CAT’’, ‘‘JAVA’’, ‘‘MAT’’ and ‘‘GPS’’. Since search activity using these symbols may have nothing to do with the attention paid to the stocks with these ticker symbols, following Da et al. (2011) and Drake et al. (2012), we manually identify and delete 63 ambiguous tickers that may cause measurement error in our attention variables.

The results, reported in Table 6 under the subtitle of ‘‘Exclusion of Tricky Symbols’’, show that the coefficient estimates on the interaction term (DES 9 DLRANK)/ (QES 9 QLRANK) are similar to the ones obtained from the sample that includes all tickers. Thereby we confirm that the findings are robust to the exclusion of tickers with ambiguous names.

Table 8 Local investor attention and pre- and post-announcements abnormal trading volume

	Pre-announcement abnormal trading volume		Post-announcement abnormal trading volume	
	(1)	(2)	(3)	(4)
LASVI	0.108***	0.093***	− 0.041***	− 0.023**
	(3.70)	(3.34)	(- 3.29)	(- 2.02)
NASVI	0.069*	0.051	− 0.010	− 0.012
	(1.71)	(1.39)	(- 0.62)	(- 0.79)
AES	− 0.096	− 0.143	0.123	0.115
	(- 0.48)	(- 0.79)	(0.92)	(0.82)
ABVOL_M		1.112***		0.997***
		(17.37)		(15.36)
IOC		0.228**		0.182***
		(2.10)		(3.08)
Log (1 + # announcements)			− 0.019**	− 0.014**
			(- 2.22)	(- 2.47)
Log (size)	0.001	0.007	0.005*	0.006**
	(0.28)	(1.60)	(1.79)	(2.33)
B/M	− 0.011	− 0.026	− 0.010	− 0.005
	(- 0.55)	(- 1.31)	(- 0.82)	(- 0.47)
Log (1 + # analyst)	− 0.000	− 0.007	− 0.019**	− 0.014**
	(- 0.03)	(- 0.67)	(- 2.22)	(- 2.47)
Log (1 + reporting lag)	− 0.021	− 0.006	0.016**	0.012*
	(- 1.48)	(- 0.44)	(2.54)	(1.91)

Earnings volatility	0.014	0.016	− 0.020	− 0.020
	(0.48)	(0.59)	(- 1.03)	(- 1.19)
Earnings persistence	0.025*	0.020	0.007	0.005
	(1.86)	(1.60)	(1.30)	(1.13)
Constant	− 0.163	− 0.335***	− 0.007*	− 0.009**
	(- 1.15)	(- 2.65)	(- 1.72)	(- 2.13)
Observations	3395	3395	3395	3395
Adj. R-squared	0.226	0.338	0.089	0.237

This table reports the effect of local investor attention on trading volume in the pre- and post-announcement period. Abnormal trading volume on a given day t is defined as the difference between natural logarithm of turnover and the average of natural logarithm of turnover over [- 40, - 11], where turnover is trading volume divided by shares outstanding. The dependent variable is AVOL, whereas preannouncement AVOL is the average abnormal turnover in the month before the earnings announcement date, and post-announcement AVOL is the average abnormal turnover over the window [2, 51] after the earnings announcement. Refer to Appendix A for detailed variable definitions. Indicators for year, month, weekdays and Fama–French 10 industry classification are also controlled. Standard errors adjusted for heteroskedasticity and clustering by the day of announcement are in parentheses

*, **, *** Statistical significance at 10, 5, 1% levels, respectively

5.5. Locations of headquarters

We notice that in our sample of S&P500 firms, there is an overrepresentation of firms located in New York and California. To examine whether our results are not driven by the firms headquartered in New York and California, we rerun analysis excluding those firms from our sample. The result presented in Table 6 under the subtitle of ‘‘Exclusion of NY and CA’’ shows that our findings are not affected by this deletion.

In summary, our results hold in the presence of several robustness checks, confirming that they are not affected by alternative explanations. Next, we examine the impact of local investor attention on the duration of delayed market reactions.

5.6. Local investor attention and PEAD over different time horizons

If informed trading, reflected in local investor attention, accelerates the process of information diffusion and reduces the information content of earnings announcements, PEAD will dissipate quickly in the post-announcement period. Therefore, in contrast with the finding in Hirshleifer et al. (2009) that investors underreact to earnings news due to distraction caused by a large flow of earnings news on certain day starting after 30 trading days following the announcement date, we predict that the impact of local investor attention will materialize quickly in the post-announcement period. In the following test, we examine PEAD over different horizons to identify when the differential in the PEAD caused by local investor attention begins, and for how long it persists. The result is presented in Table 7. As we can see, the significant differential appears 31 trading days after earnings announcements (BHAR [2, 31]), and lasts for 51 trading days after the announcements (BHAR [2, 51]). Then, the impact loses its statistical significance following 75 trading days (BHAR [2, 75]). Since, consistent with past studies (e.g., Bernard and Thomas 1989), the PEAD for S&P 500 firms exists for about 61 trading days after the earnings announcement, the impact of local investor attention on PEAD is also present throughout the PEAD period

until PEAD diminishes. This is consistent with the hypothesis that the impact of local investor attention has an immediate and long-lasting impact on PEAD.

5.7. Local investor attention and abnormal trading volume

Investors' reaction to earnings news can also be assessed by the response of trading volume to earnings announcements. The evidence in the literature suggests that high abnormal trading volume is associated with the arrival of new information (Glosten and Milgrom 1985; Easley and O'Hara 1987; Pan and Poteshman 2006).[17] If the high arrival rate of informed traders accelerates information transmission among investors, two interesting results should be observed. First, since local investor attention is accompanied by the arrival of informed trading, high (low) local attention should lead to large (small) abnormal trading volume in the pre-announcement period. Second, high (low) local attention should lead to small (large) abnormal trading volume in the post-earnings announcement period because the information diffusion caused by the arrival of informed trading weakens opinion divergence among investors and reduces the information content of earnings announcement.[18]

We define the abnormal trading volume on a given day as the difference between natural logarithm of turnover on that day and the average of natural logarithm of turnover over days [- 41, - 11]. Turnover is measured as trading volume divided by shares out- standing. Thus, for each earnings announcement, we calculate the abnormal trading volume on a given day t using the following measure:

$$AVOL_t = Log(Turnover_t) - \frac{1}{30}\sum_{k=t-41}^{t-11} Log(Turnover_k)$$

We then regress average abnormal trading volume on local attention, national attention and other control variables. We also control for the contemporaneous market-level abnormal trading volume considering it as a potential source that can drive our results. The market-level abnormal trading volume on a given day is calculated as the average abnormal volume of all CRSP firms on that day where the abnormal volume of each firm is obtained by the same measure.

Columns (1) and (2) of Table 8, focusing on pre-announcement trading volume, shows that the coefficient on LASVI is positive and significant at 1% level, indicating that high local investor attention is associated with large abnormal trading volume at pre-announcement period. This finding further confirms that local investor attention can be used as proxy for the arrival rate of informed trading. Although in Table 8 column 1, the coefficient on NASVI is also positive and significant, its effect on the abnormal trading volume

[17] Regarding these studies, Glosten and Milgrom (1985) demonstrate how trade imbalances might force prices to their full information value, whereas Pan and Poteshman (2006) examine the relation between trading volume, price and private information in the derivative markets. On the other hand, Da et al. (2011) find that direct measure of investor attention by SVI is highly correlated with abnormal trading volume. Another study of Gao et al. (2012) shows that daily abnormal dollar trading volume is positively associated with contemporaneous abnormal ticker search.

[18] Theoretical work by Holthausen and Verrecchia (1990) and Kim and Verrecchia (1994) implies that investors' opinions may diverge more as the information content of a news announcement increases. Garfinkel (2009) confirms this prediction empirically.

disappears once we control for the market-level abnormal trading volume and the change in the institutional ownership in column (2).

Next, we focus on the post-announcements abnormal trading volume in columns (3) and (4). Consistent with our prediction, the coefficient on LASVI is negative and significant, indicating that the local investor attention before earnings announcement accelerates information diffusion among market participants and weakens investors' response to earnings news in the post-announcement period. In contrast, the finding that national investor attention has no effect on the abnormal trading volume after the earnings announcement implies that national investor attention is not driven by the arrival of private information and cannot proxy for the arrival of informed trading. Overall, the evidence on the relation between local investor attention and abnormal trading volume further corroborates our findings on the impact of local investor attention on PEAD.

6. Conclusion

In this paper, we document that high local investor attention caused by private information due to geographical proximity to investment opportunities weakens PEAD. We argue that the informed trading by local investors before earnings announcements accelerates the process of information transfer from informed traders to uninformed traders and increases information diffusion among investors, causing prices to converge toward levels that fully reflect the news. Consistent with Vega (2006), our findings support the ''rational structural uncertainty'' theory, which argues that information distribution among investors plays an important role in explaining market anomalies. Also, we provide evidence in support of the ''attention allocation'' theory, which argues that investors allocate more attention to local investment opportunities upon the arrival of private information. The evidence also sheds new light on the ongoing debate about whether individual investors have value-relevant information advantages about local firms.

In addition, since the extent to which investors react to earnings news can also be measured by the response of trading volume to the earnings announcement, our finding that higher local investor attention leads to weaker trading volume in the post-announcement period indicates that information acquisition by local investors helps diffuse information and reduce the opinion divergence among market participants.

In conclusion, the evidence documented in this paper provides new insight into the role of information in explaining PEAD, the heterogeneity between local and national investors regarding the nature and timing of investor demand for information, and the discrepancy of the impact on price and trading after the earnings announcement.

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