Investor Attention: Seasonal Patterns and Endogenous Allocations [†]

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Keywords: Limited attention, information processing, attention allocation, information efficiency

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Abstract

Using a Google search-based measure of investor attention, this paper investigates investor attention patterns and its determinants. We document that investor attention displays strong seasonality. It is significantly lower on Fridays and in summer months. We find that investor attention increases significantly following earnings announcements and macro news releases, and the effect is stronger for large firms. When faced with both firm-specific and market-wide information shocks, investors' attention response to firm-specific information attenuates and their trading behavior is also affected. Our evidence suggests that investors actively allocate their attention in response to information shocks and prioritize their information processing to large firms and systematic shocks, as suggested by models of rational inattention.

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1. Introduction

Standard asset-pricing models are typically based on the assumption that markets distill new information with lightning speed and that they provide the best possible estimate of all asset values. In reality, such distillation and estimation requires investors' close attention to processing information and incorporating this knowledge into their decisions. Yet, attention is a scarce cognitive resource (Kahneman, 1973). A large body of psychological research shows that there is a limit to the central cognitive-processing capacity of the human brain.[1]

Several studies provide a theoretical framework in which an attention-constrained agent rationally determines attention allocation and information processing. Sims (2003) applies information theory to study information-processing constraints in a dynamic control problem. Using the same technique, Peng (2005) analyzes the attention allocation decisions of a representative investor and its asset pricing implications. Peng and Xiong (2006) model the attention allocation decision with respect to systematic information shocks and firm-specific information shocks. On the other hand, Barber and Odean (2008) posit that investor attention can be driven by salient events, whether or not paying attention to these events is optimal.

There has been a growing body of theoretical models and empirical evidence that suggest the importance of investor attention in determining investor's trading behavior, the dynamics of asset prices, and firms' disclosure decisions.[2] However, most of these works take limited investor attention as given, without investigating its determinants.

Motivated by the theoretical models of rational inattention, this paper fills this gap in the literature by empirically examining the patterns of attention and its determinants. Using an attention measure based on daily Google search volume for individual stocks' ticker symbols, we investigate the following three questions. First, what are the time

[1] See Pashler and Johnston (1998) for a recent review of these studies.

[2] See, for example, Merton (1987), Gervais, Kaniel, and Mingelgrin (2001), Huberman and Regev (2001), Hirshleifer and Teoh (2003, 2004), Grullon, Kanatas, and Weston (2004), Hirshleifer, Hou, Teoh, and Zhang (2004), Hou and Moskowitz (2005), Peng (2005), Peng and Xiong (2006), Seasholes and Wu (2007), Barber and Odean (2008), Cohen and Frazzini (2008), Lou (2008), Chemmanur and Yan (2009), Dellavigna and Pollet (2009), Hong, Torous, and Valkanov (2007), Van Nieuwerburgh and Veldkamp (2010), Da, Engelberg and Gao (2011, 2015), Hirshleifer, Lim, and Teoh (2011), Hirshleifer, Hsu, and Li (2013), Hou, Peng, and Xiong (2013), Bali, Peng, Shen and Tang (2014) and Yuan (2014).

series properties of investor attention? Second, how do investors change the level of attention allocated to stocks in response to information shocks? Third, how do investors allocate their limited attention among different types of information?

We first provide descriptive analysis of the time-series pattern of investor attention. Dellavigna and Pollet (2009) argue that investor attention is lower on Fridays and Hong and Yu (2009) assume that both institutional investors and retail investors have "gone fishin'" in the summer. Using a direct Google search-based attention measure, we confirm that investor attention exhibits a strong seasonality pattern; attention to individual stocks is significantly lower on Fridays and in summer months (July and August). The pattern is robust after controlling for the number of firm-specific news announcements, suggesting that this seasonal pattern is not simply driven by variations in information volume. Thus, our evidence directly substantiates the conjectures made by Hong and Yu (2009) and Dellavigna and Pollet (2009). We also perform VAR analysis to demonstrate that investor attention is an important determinant of trading volume and price volatility.

We then examine how investors allocate their attention to stocks in response to information shocks. We focus on two types of information shocks: firm-specific information shocks in the form of earnings announcements and market-wide information shocks as captured by twenty-nine macro news announcements.

We find that, compared to new news days, attention to stocks increases by 5.72 percentage points on days of the firm's own earnings announcements and 0.74 percentage points on days of macro announcements. The results suggest that investors actively respond to both macro news and firm-specific information shocks by allocating more of their attention to the stock market. Furthermore, we find that while the attention response to information exists for all firms, the effect is stronger for large firms. This result is consistent with the rational attention allocation hypothesis of Peng (2005), who shows that, since large firms contribute more to the uncertainty of a portfolio, it is more effective for an investor to allocate more attention to large firms. The result could also be explained by the fact that since large firms tend to have more salient news coverage, attention can simply react to the more salient news, as argued by Barber and Odean (2008).

We further study how investors allocate their limited attention among multiple sources of information. Peng and Xiong (2006) argue that investors with limited attention rationally process more market-wide information than firm-specific information, especially when faced with large macroeconomic uncertainties. The intuition is that, given limited attention, it is more effective to concentrate on common factors that have a larger impact on the uncertainty of their portfolio. We test this theoretical prediction by comparing the attention to earnings announcements made on days with macro news announcements and on days without macro news announcements.

Consistent with the prediction, we find that earnings announcements made on days without major macro news releases trigger an abnormal attention of 10.56 percentage points and those announced on days with macro releases correspond to an abnormal attention of only 8.97 percentage points; the difference is statistically significant. Results from multivariate panel regression analysis also confirm that, while the earnings announcement dummy and macro dummy are both positive and significant in determining abnormal attention, the interaction of the two dummy variables is significantly negative.

In terms of the response of investor attention to firms' earnings announcements, we find that it is stronger for large firms, firms with more analysts following, large earnings surprises, and weaker when there are confounding macro news or other firms' earnings announcements. The last finding also provides direct support to Hirshleifer, Lim, and Teoh (2013), who argue that confounding earnings announcements distract investors and lowers the attention allocated to each announcement.

Furthermore, we find that trading volume on the earnings announcement days is significantly lower if there is a concurrent macro news release. Combined with the evidence from VAR analysis that attention drives volume, the results suggest that investors' trading behavior is consistent with their attention allocation.

This paper contributes to the literature by not only confirming the key assumptions made by previous work, but also by providing new evidence that sharpens our understanding of the determinants of investor attention. These results support the idea that investors do have limited attention and that they react to information shocks and

allocate attention in a way that is consistent with rational optimization behavior. The results provide insight on how investor attention can affect asset prices.

The remainder of the paper is organized as follows. Section 2 summarizes the previous literature on investor attention. Section 3 describes data sources and sample construction. Section 4 provides descriptive analysis of the seasonal patterns of attention, and Section 5 examines attention and information shocks. Section 6 concludes the paper.

2. Literature Review

A large body of economics and finance literature has studied investors' limited attention. In the cross-section, Peng (2005) studies investors' endogenous attention allocation and predicts that larger stocks, which tend to contribute more to the total fundamental uncertainty of an investor's portfolio, are likely to receive more attention from investors. Higher investor attention on large stocks then translates to a faster price adjustment to information shocks and higher price informativeness. This paper empirically tests these predictions.

Peng and Xiong (2006) model the investors' strategy in allocating their limited attention and study its effect on asset-price dynamics. They show that limited investor attention leads to category-learning behavior, i.e. investors tend to process more market and sector-wide information than firm-specific information. The intuition is that given limited time and cognitive resources, processing more market-wide or sector-wide information than firm-specific information is more efficient in reducing portfolio uncertainty. Combined with investor overconfidence, investor limited attention generates excess comovement and low price informativeness.

Previous literature has also studied the impact of investors' limited attention on asset prices and investors' trading behavior. Barber and Odean (2008) show that individual investors' are net buyers of attention- grabbing stocks. Da, Engelberg, and Gao (2011) also provide strong support for this argument. They use search volume index (SVI) from Google Trends to proxy for investor attention and find that an increase in SVI predicts higher stock prices in the following two weeks and an eventual price reversal within the year.

Papers have shown that limited attention helps to explain investors' underreaction to news. Dellavigna and Pollet (20112) and Hirshleifer, Lim, and Teoh (2013) both find that lower investor attention is associated with lower immediate reactions and higher delayed reactions to firms' earnings announcements. Dellavigna and Pollet (2011) use Friday as exogenous variation in investor attention. The assumption is that investors are more likely to be distracted by the upcoming weekend and pay less attention to investment- related information. Hirshleifer, Lim and Teoh (2013) support this finding using the number of earnings announcements as a proxy for investor attention. They assume that investors pay less attention to each piece of information as the total number of earnings announcements increases.

Papers have shown that limited attention helps to explain underreaction in other settings as well. Using abnormal trading volume as a proxy for investor attention, Loh (2010) confirms that low-attention stocks react less to stock recommendations than high-attention stocks using three-day event windows. Drake, Roulstone, and Thornock (2012) examine this question from the opposite perspective. They find that abnormal attention before the release of earnings announcements is negatively associated with immediate price reactions, suggesting that investor attention before the earnings announcements preempts its information content.

Previous papers have used indirect measures of attention such as abnormal trading volume (Barber and Odean (2008), Hou, Peng, and Xiong (2009), Loh (2010)), abnormal return (Barber and Odean (2008)), and media news (Barber and Odean (2008)). The assumption is that a stock's abnormal return, trading volume and media news closely relates to investor attention. However, a stock's return or trading volume can be driven by other factors, and media mention does not guarantee investor attention either. Huberman and Regev (2001) show a vivid example where previous media coverage by Nature, a science journal, and the New York Times failed to attract investors' attention to the breakthrough discovery of a cancer drug by Entremed. Only after a front page article on the same news, months later, did the stock price surge. Furthermore, using Google search-based attention measures, Da, Engelberg, and Gao (2011) show that the relationship between attention and abnormal return or abnormal volume is quite low and that there is little correlation between attention and news.

3. Data and Variable Descriptions

Our sample consists of stocks that are included in the S&P 500, S&P 400, and S&P 600 indices between January 2004 and December 2013. We choose these S&P 1500 stocks to make data collection and cleaning manageable, while maintaining a reasonable degree of cross-sectional variation in the type of stocks. We start with all of the 2,251 stocks ever included in the S&P 1500 index during the sample period to ensure that our results are free of survivorship bias and index changes.

Data used in this paper comes from five sources. We obtain the measure for investor attention from Google Trends, whose coverage begins on January 2004, macro news announcements from Bloomberg, firms' quarterly earnings announcements from I/B/E/S and COMPUSTAT, firm fundamental information from COMPUSTAT, and stock-related information from CRSP. We include only common stock and require that a firm be included in the COMPUSTAT-CRSP merged database.

Our main variable of interest, abnormal investor attention (*AbnAttention*), is constructed using search frequency data from Google (Search Volume Index (SVI)). Following Da, Engelberg, and Gao (2011), we download the daily Search Volume Index (SVI) for a firm's ticker symbol to construct a measure of investor attention.

Google Trends provides information on how often a particular search term is entered in Google Search by reporting the search volume index (SVI), defined as a term's search frequency on a day relative to the highest frequency over a specified period. As argued by Da et al. (2011), search frequency in Google is a direct and unambiguous measure of investor attention for the following two reasons. First, Google dominates the web search market and its reported search volume is likely to be representative of the internet search behavior of the general population. Second, and more importantly, searching for a stock via Google is a direct indication that active attention has been devoted to the stock. Similar arguments are also made by Choi and Varian (2009) who find that search data can predict home sales, automotive sales, and tourism, and Ginsberg et al. (2009) who find that search data can predict flu outbreaks. Other papers that employ Google search frequency are Mondria, Wu, and Zhang (2010), Drake et al. (2012), among others.

We define *AbnAttention* as the difference between a ticker's daily SVI and its average SVI from day -360 to day -31, scaled by the average.

$$AbnAttention_{i,t} = \frac{SVI_{i,t} - Average\ SVI_{i,(t-360,t-31)}}{Average\ SVI_{i,(t-360,t-31)}} \quad (1)$$

The past year average captures the baseline level of attention that is free of any monthly and weekday seasonalities. Thus, *AbnAttention* captures the deviation of attention from the normal level and any potential time trends. For example, an *AbnAttention* value of 30% indicates that the search interest on a particular day is 30% higher than its past one year average. We exclude the most recent month in computing the average to avoid potential spillover effects in attention.

We require that at least 60 days of *SVI* data be available during the sample period for a firm to be included in the analysis. [3] We also manually screen all of the tickers to select those that do not have a generic meaning (e.g., "GPS" for GAP Inc., "M" for Macy's) to ensure that the search results we obtain are really about the stock, not other generic items or products of the firm.[4] These restrictions result in a final sample of 1,316 firms and 2,818,625 firm-day observations.

Table 1 shows the composition of our final sample. Out of the 2,250 firms we start with, about 59% remains: 73% of the S&P 500 firms, 63% of the S&P 400 firms, and 45% of the S&P 600 firms. This is due to the fact that Google Trends does not return a valid SVI if a ticker is rarely searched; and this truncation is more likely to occur for small stocks.

For illustrative purposes, we plot *AbnAttention* for American International Group Inc. (AIG) in Figure 1 and Apple Inc. (AAPL) in Figure 2. Figure 1 shows that *AbnAttention* to AIG was the highest during the most recent financial crisis. It spiked on September 16, 2008 (about 3100% higher than the normal level) when the Federal Reserve Board authorized the Federal Reserve Bank of New York to lend up to $85 billion to the American International Group. The high attention level persisted for a few

[3] 691 firms are dropped in this stage.

[4] 145 firms are dropped in this process.

days and jumped again on October 8, 2008 when the Federal Reserve Bank of New York announced that it would lend another $37.8 billion to AIG. In Figure 2, we observe that the highest attention to AAPL occured on October 6, 2011, one day after Steve Jobs, the founder of Apple, passed away at 3pm. High attention for Apple Inc. also occurs on new product release days and earnings announcement days. This is consistent with the fact that investors actively analyze the impact of news on firms' prospects via Google searches. These examples suggest that the *AbnAttention* measure captures changes in investor attention and response to important news events.

To test investors' attention response to firm-specific news, we focus on firms' quarterly earnings announcements. All publicly traded U.S. firms need to make earnings announcements regularly, and it is by far one of the most important sources of information for investors. We extract information about firms' earnings announcements from I/B/E/S and COMPUSTAT. For our sample, there are 30,733 quarterly earnings announcements, of which 27,337 are covered by the I/B/E/S database. Following Dellavigna and Pollet (2009), we adopt the earlier date when there is a discrepancy between the announcement dates recorded in I/B/E/S and COMPUSTAT. Because investors are more likely to pay attention to a firm during trading hours, we identify investor attention to an earnings announcement as the attention on the first trading day after the news announcement. Therefore, if an announcement is made before or during trading hours, we match it with *AbnAttention* measured on the same day. If the news is announced after trading hours or during a holiday, we match it with *AbnAttention* for the next trading day.

We measure the magnitude of earnings surprises using standardized unexpected earnings (SUE). It is defined as the difference between the actual earnings and the median analyst forecasts over the 90-day period prior to the actual announcement, scaled by stock price as of the fiscal quarter end date. If an analyst makes multiple forecasts during the period, we use only the most recent one. We delete observations when actual EPS or forecasts are higher than the stock price, or when the stock price is below $5.

$$\text{SUE}=\frac{Actual\ EPS-Median\ forecasted\ EPS}{Stock\ price\ at\ the\ fiscal\ quarter\ end}$$

To study the effect of market-wide shocks on investor attention, we obtain information for twenty-nine important macro news releases from Bloomberg. Examples of these releases include GDP, non-farm payroll, and CPI, with the full list shown in Appendix 2. We report the number of observations, start and end date in our sample, release date and time, and the relevance value for each news type. Relevance value (ranging between 0 and 100) is a measure of the importance of macro news assigned by Bloomberg. It is constructed based on the number of subscriptions by investors. GDP data and employment statistics are among the most important news for investors, according to the relevance value. Out of the 3,286 calendar days in our sample period, 1,654 days have at least one macro news announcement. Since almost all macro news are announced before or during trading hours, we match *AbnAttention* with the same day of the macro news announcements.

To test if investor attention has an impact on trading activities, we construct an abnormal trading volume (*AbnTurnover*) measure, which is defined as the difference between turnover on a particular day and the average daily turnover for the past year, skipping the most recent month:

$$AbnTurnover = Turnover_t - Average\ turnover_{(t-21,t-252)}$$

4. Descriptive Analysis of Investor Attention

Summary statistics of the abnormal attention measure are shown in Table 2. The mean and median for *AbnAttention* are both close to zero, suggesting that the attention a firm receives on a typical day is close to its past one-year average. The standard deviation is 28.754%, suggesting that there is considerable cross-sectional and time-series variation in attention.

4.1 Day of week pattern

Motivated by Dellavigna and Pollet (2009), who posit that investor attention is low on Fridays, we study the patterns of investors' attention across different weekdays. We compute and plot the mean and median of *AbnAttention* for different weekdays and test whether they are statistically different using both a difference of means test and a non-parametric median test.

Table 3 summarizes the day-of-week patterns of abnormal attention. Panel A presents the mean and median *AbnAttention* and the total number of earnings announcements for all firm-day observations. Panel B presents the mean and median *AbnAttention* for firm-days with earnings announcements. Panel C compares the mean and median *AbnAttention* on days with versus without earnings announcements for the same day of the week. Standard errors for the means test are adjusted for heteroskedasticity and clustered by date.

Panel A shows that the means of *AbnAttention* on Monday through Thursday are 3.85%, 4.65%, 4.33%, and 3.80%, respectively, with the average of the weekday means being 4.16%. In contrast, *AbnAttention* for Friday is only 1.57%, and is significantly lower than the average attention for the other four weekdays. Weekend days have an even lower level of abnormal attention, -7.4% for Sundays and -7.9% for Saturdays, suggesting that investors' attention to stocks is mostly during trading days. The day of the week attention pattern is also illustrated in Figure 3, which shows consistent patterns.

One may argue that the lower number of google searches for a stock on Fridays does not necessarily mean that investors are paying less attention to the stock. It could be that there are not as many Friday news releases. To control for the amount of information, we count the number of earnings announcements on each weekday. Figure 3 and Panel A in Table 3 indeed show that the number of earnings announcements is considerably lower on Fridays (2,126 announcements) than on the other four weekdays (an average of 7,117).

To examine the amount of investor attention associated with each earnings announcement, we focus on a subsample of firm-day observations with earnings announcements. Panel B shows that while the earnings announcements released on Mondays through Thursdays are associated with a mean (median) *AbnAttention* of 9.14% (4.53%), Friday announcements are associated with a mean (median) *AbnAttention* of 5.41% (1.73%). The difference in means is -3.73% and in medians is -2.80%, both significant at the 1% level. The result confirms that Friday earning announcements do indeed attract less investor attention. The pattern is also demonstrated in Figure 4.

One may also argue that the baseline levels of attention, when there is no earnings announcement, on Fridays could simply be low. To address this concern, we then

compare *AbnAttention* associated with earnings announcements from Panel B with the average attention for the same weekday without earnings announcements. Panel C presents the results. It shows that, for Mondays through Thursdays, earnings announcements generate 5.78% higher levels of attention than the baseline level for those weekdays. Friday announcements only generate 4.28% higher levels of attention than the baseline level. The difference is 1.03% and statistically significant.

Thus, even after controlling for the number of earnings announcements, and after controlling for the low level of baseline attention on Fridays, we find that the amount of attention paid to Friday earnings announcements is significantly lower than the attention paid to other weekday announcements. The findings suggest that investors are generally less attentive to news released on Fridays.

Our result substantiates the assumptions made in Dellavigna and Pollet (2009), that investor attention is lower on Fridays, and support the story that Friday earnings announcements generate weaker immediate reactions and that greater post earnings announcement drifts are due to investor inattention.

4.2 Month of year pattern

Next, we examine the seasonality of investor attention across different months of the year. Hong and Yu (2009) hypothesize that investors tend to have "gone fishin" during the summer months and are less attentive to the stock market, and find that summer month trading volumes are significantly lower than other months.

In Panel A of Table 4, we present the mean and median abnormal attention for different months of the year. The table shows that abnormal attention to stocks is considerably low in the summer months of July and August, with average levels of -0.49% and 0.06%, respectively. The average level of abnormal attention for the summer months is significantly lower than the average level of abnormal attention for the other months, with a difference of 0.76%. This fact is surprising, especially for the month of July, given the fact it contains a large number of earnings announcements, at 4,217, second only to October. Thus, it is unlikely that the lower amount of attention in July is because news is scant.

It is also worth noting that the abnormal attention level is also very low for the month of December. However, since there are only 518 earnings announcements in December, it may not necessarily be the case that December announcements attract less investor attention.

In order to account for the possibility that the amount of news supplied to the market may differ from month to month, we examine abnormal attention associated with earnings announcements by focusing on the subsample of firm-days with earnings announcements. The results are presented in Panel B of Table 4. *AbnAttention* associated with earnings announcements is lowest for the months of July and August. The average difference in *AbnAttention* between these two summer months and the rest of the year is 1.82% and is statistically significant. On the other hand, *AbnAttention* for December earnings announcements are similar to those in May, June, and November.

In Panel C, we compare *AbnAttention* associated with earning announcements with the baseline level of attention for the same month, excluding earnings announcement days. The difference gives a clean measure of the effect of earnings announcements on investor attention, while controlling for potential differences in the baseline level across months. The results show that the average increase in *AbnAttention* for earnings announced during July and August are 8.34% and 8.94%, respectively. The average *AbnAttention* difference for these two months is 1.03% lower than the average difference across all other months and is statistically significant. However, there are other months in which earnings announcements generate an even smaller increase in *AbnAttention*, such as, May, February. and August. More surprisingly, given that the baseline level of attention in December is so low (at -4.27%), earnings announced during this month actually generate an *AbnAttention* difference of 13.1%, the highest among all of the months. The result is also illustrated in Figures 5 and 6.

Our results thus confirm the “gone fishin” conjecture made in Hong and Yu (2009) that investors are less attentive to stock market during the summer. However, our results using a direct measure of investor attention, show that the attention associated with each piece of news may not necessarily be small during these months.

4.3 The dynamic relation between attention, trading volume, return, and volatility

In this section, we describe the dynamic properties of daily investor attention, as well as the effect of attention on financial markets in terms of abnormal trading volume (*AbnTurnover*), return, and volatility (*Absolute return*) using a vector autoregression system (VAR). We choose to include four lags for the VAR system as suggested by optimal lag selection criterion. Following a methodology that is similar to Da et al (2011), we first perform VAR analysis for each stock, and then average the coefficients across stocks to form the mean estimates. Standard errors are obtained using block-bootstrap at the stock level, with replacement of 5000 times. P-values are calculated assuming a normal distribution.

Results of the VAR are presented in Table 5, with Panel A showing raw returns and Panel B showing abnormal returns. We find that *AbnAttention* is quite persistent, with all four lags significant. *AbnAttention* also significantly increases trading volume and price volatility on the following day.

On the other hand, past return significantly increases *AbnAttention.* Return is also negatively serially correlated, consistent with the short-term reversal of returns due to microstructure effects. Trading volume and volatility are also quite persistent themselves, but they do not significantly affect *AbnAttention*.

These results suggest that investor attention has important implications on asset prices, trading, and volatility. Therefore, it is important to understand the determinants of attention and how investors make decisions in attention allocation and information processing.

5. Attention and Information Shocks

In this section, we investigate how investors allocate attention in response to information shocks. We employ two forms of information shocks, firm-specific information shocks in the form of earnings announcements, and systematic information shocks in the form of macroeconomic news releases. We first analyze investors' attention responses to each type of shock separately, and then study investors' attention allocation decisions when these two types of shocks occur at the same time.

5.1 Attention response to firm-specific news

In this section, we focus on firm level information shocks in the form of earnings announcements. We analyze investors' attention response to earnings announcements by comparing investors' attention on firm days with earnings announcements and firm days without earnings announcements. The results in Panel A of Table 6 show that *AbnAttention* is 9.28% on days with earnings announcements and 3.56% on other days, yielding a statistically significant difference of 5.72%.

The results suggest that investors actively pay attention to information revealed through earnings announcements. This is also consistent with predictions of the rational inattention models (Sims, 2003, and Peng, 2005), that investors actively increase their attention when there are information shocks that increase the uncertainty of the asset. In a frictionless world, when information can be processed immediately with infinite precision, earnings announcements generally reduce uncertainty. However, when investors have limited attention, it takes them time to process information, thus, information shocks lead to an increase in uncertainty, and only after devoting attention to process information can uncertainty be reduced. The results are also consistent with Barber and Odean (2008) who argue that investor attention increases in response to salient news and headlines.

We next investigate how attention's reaction to earnings announcements may differ in the cross section. Peng (2005) models the attention allocation of an investor whose portfolio consists of multiple stocks and shows that attention constrained investors would optimally allocate more attention to larger stocks in their portfolio, as these stocks contribute a greater amount to their total portfolio uncertainty and thus processing information about these firms would have the greatest benefit. It is also possible that large firms receive more coverage from news media outlets, such that large firms' announcements attract a greater amount of attention from investors as their news are more salient, consistent with Barber and Odean (2008).

We sort firms into five quintiles by their market capitalization as of June based on NYSE size breakpoints. We then compare the attention response to earnings announcements across different size groups and report the result in Panel B of Table 5. It shows that, while the increase in attention is significant for all size groups, large firms' earnings announcements receive a significantly greater amount of attention, an increase

of 15.4% for the largest firms on earnings announcement days, when compared to no announcement days. In contrast, small firms' attention only increases by 1.32% on earnings announcement days. The difference is 14.1% and highly significant.

Thus, the result suggests that earnings announcements are associated with greater investor attention, and the increase in attention is highest for the largest firms. The result is consistent with the rational attention allocation hypothesis as well as the salient news hypothesis.

As a robustness check (reported in Appendix 3), we exclude both weekends and firm days with macro news announcements to address the concern that the result may be contaminated by other sources of information. The results are even stronger. The average *AbnAttention* is 7.52% higher on earnings announcement days. The increase of attention associated with earnings announcements is 15.5% higher for firms in the largest quintile than those in the smallest quintile.

5.1 Attention response to systematic news

In this section, we analyze investors' attention response to systematic information shocks in the form of 29 macroeconomic announcements. In Panel A of Table 6, we compare investor attention on macro news announcement days with attention on non-macro news announcement days. The mean of *AbnAttention* is 3.86% on the macro-announcement days and 3.12% on the non-macro-announcement days. The difference is 0.74% and highly significant. The result indicates that macro announcements lead to increased information processing for individual stocks, as investors are eager to figure out the impact of macro shocks on individual companies.

Another interesting pattern to observe is that, although attention responds significantly to both earnings announcements and macroeconomic announcements, the magnitude is very different. The average earnings announcement generates an increase in *AbnAttention* of 5.72%, while the average macroeconomic announcement only increases *AbnAttention* by 0.74%.

In Panel B of Table 6, we compare the attention response to macro news announcements for firms of different sizes by examining *AbnAttention* for firms sorted into size quintiles. The attention response increases with size: 0.436% for the smallest

firms and 1.48% for the largest firms. The difference is 1.04% and is significant at the 1% level. These results show that investors pay close attention to macro level news and large firms are the ones that they particularly focus on. Presumably, analyzing the reaction of large cap stocks and sector leaders are investors' ways of digesting the effect of macro news on the economy.

To address the concern that the result may be contaminated by other sources of information, we exclude firm-days with earnings announcements and report the results in Appendix 4. The results are very similar.

Overall, the results on attention response to macroeconomic announcements suggest that investors increase their attention to stocks in a way that is consistent with both the rational attention allocation hypothesis as well as the salient news hypothesis.

5.3 Attention allocation across different types of information

In this section, we analyze how investors allocate their limited attention across different types of news. Peng and Xiong (2006) model investor attention allocation decisions when faced with firm-specific news, market wide news and sector wide news. The model predicts that, upon market wide information shocks, attention constrained investors will shift attention away from processing firm-specific information and allocate more attention to market wide news, as this allocation reduces their portfolio uncertainty more effectively.

We test this hypothesis by comparing attention for firms' earnings announcements on macro news announcement days and non-macro news announcement days. The prediction is that the attention response for an individual firm's earnings announcement should be lower if important macro news is announced on the same day.

The results are shown in Panel A of Table 7. *AbnAttention* for earnings announcements is 10.56% on days without macro news, but it reduces to 8.97% on macro news days. The difference is -1.59% and statistically significant. The finding suggests that there is indeed a limit to investor attention and that investors have to shift attention away from processing firm-specific information on days with large macroeconomic information shocks, consistent with Peng and Xiong (2006).

In Panel B of Table 7, we sort firms into five portfolios based on market capitalization and investigate the cross-sectional variations. The results show that the attenuation effect is concentrated in medium-sized firms and the effect is weak for very large firms and very small firms: the difference between *AbnAttention* for earnings announced on macro news days versus non-macro news days are 0.45%, 3.67%, 1.58%, 1.93% and 1.32% for firms belong to size quintiles 1 through 5, respectively.

One explanation is that investors process macroeconomic news announcements through analyzing their impact on large firms that are market or sector leaders, and this increased attention offsets the effect of attention shifts. Very small firms, on the other hand, do not attract much investor attention even on the days without macroeconomic news, thus macro news do not have much impact on the attention to these firms.

Not all macroeconomic releases are equally important and they will have different impacts on investors' attention allocation decisions. We select five of the most important macro news based on the criteria that the Bloomberg relevance score needs to be higher than 95. These macroeconomic releases include GDP, non-farm payroll, ISM manufacturing, initial jobless claims, and FOMC rate decision.

We compare investor attention associated with earnings announcements on firm-days with important macro news and firm-days with no macro news. The results are presented in Table 9. The results show that *AbnAttention* for earnings announcements is 10.56% on days without macro news, but it reduces to 8.12% on the five most important macro news days, a further reduction from the 8.97% presented in Table 8 for all macro news events.

In terms of cross-sectional patterns, *AbnAttention* to earnings announcements is lower on days with these five important macro news announcements for all of the firms, and the difference is significant for all except the smallest ones. This suggests that important macroeconomic news shifts investor attention away from analyzing firm-specific shocks for most of the firms in the market.

5.4 Multivariate Tests

To jointly control for other possible determinants of investor attention, we perform multivariate panel regressions. The dependent variable is *LogAttention*, defined

as ln(*AbnAttention*+1). We make the log transformation so that the distribution of the dependent variable is closer to a normal distribution.

In order to control for other possible determinants of investor attention, we run regressions of *AbnAttention1* on an earnings announcement day dummy, macro news announcement dummy, an interaction term of the two, and a series of control variables:

$$LogAttention_{i,t} = \alpha_0 + \alpha_1 I_{i,t}^{earnings} + \alpha_2 I_t^{macro} + \alpha_3 I_{i,t}^{earnings} * I_t^{macro} + Control_{i,t} + \epsilon_{i,t} \quad (1)$$

Where $I_{i,t}^{earnings}$ is a dummy variable that equals to one when there is an earnings announcement for firm *i* on day *t* and zero otherwise, and $I_{i,t}^{macro}$ is a dummy that equals to one when there is macro news announcement on day *t* and zero otherwise. The control variables we include in the regression are the logarithm of firm size, book to market, day of week fixed effect, and month of year fixed effect.

Analysis in the previous section suggests that investor attention increases in response to earnings announcements and macro news announcements. It also shows that the attention response for earnings announcements is attenuated by macro news announcements. Thus, we expect α1 and α2 to be positive and α3 to be negative.

The regression results are reported in Table 8. As shown in Column 1, the coefficient on the earnings announcement dummy is 0.126 and significant at 1% level. This suggests that attention is significantly higher on the day of earnings announcements. In Column 2, we regress $LogAttention_i$ on the macro news day dummy. The coefficient on the macro news announcement day dummy is 0.119 and significant at the 1% level, suggesting that investor attention is significantly higher on macro news announcement days. In Column 3, we regress $LogAttention_i$ on the earnings announcement dummy, the macro news announcement dummy, and the interaction of the two. Consistent with our expectation, the coefficient on the interaction term is -0.142 and significant at the 1% level, implying that upon receiving macro shocks, investors shift their attention away from analyzing firm-specific information. In Column 4 and Column 5, we add additional control variables such as day of week and month fixed effects, as well as firm size and book-to-market ratio, and the results are very similar. Size, book-to-market ratio, and the size dummy variable are insignificant. This is as expected because the dependent variable

LogAttention is demeaned and only captures changes in investor attention, thus does not vary with fixed firm characteristics.

In Columns 6 and 7, we allow for the interaction of information dummies with firm size to examine the potential cross-sectional variations of attention determinants. I_{large} equals one if firm size is in the top size quintile and zero otherwise. The coefficient on the interaction term between the earnings announcement dummy and the large firm dummy is positive (0.132 without controls, 0.133 with controls) and significant at the 1% level. Similarly, the coefficient on the interaction term between the macro news announcement dummy and the large firm dummy is also positive and significant at 1% level. This suggests that the attention response to earnings and macro news announcements are especially more pronounced for large firms.

Overall, these results are consistent with the one-dimensional sorting results we established earlier. They show that investors increase the amount of attention they pay to stocks in response to earnings announcements and macroeconomic releases, and that there is a substitution effect in that macro announcements shift investor attention away from processing firm-specific information shocks.

We next focus our analysis on investors' attention response to earnings announcements by examining a subsample including only firm-day observations with an earnings announcement. In doing so, we are able to control for more variables that are associated with each announcement and investigate how the degree of attention response to earnings announcements depends on other confounding information events, the nature of earnings surprises, and firm characteristics.

We regress *LogAttention* on the macro news announcement dummy, absolute earnings surprise, natural logarithm of the number of analysts following plus one, natural logarithm of the number of same-day earnings announcements, firm size or large firm dummy, and book to market. Day of week and month fixed effects are included and p-values for regression coefficients are constructed with robust standard errors, double clustered by firm and day.

The regression results are reported in Table 11. In Column (1), the coefficient on the natural logarithm of size is 0.0365 and significant at the1% level, suggesting that investor attention responds more to large firms' earnings announcements. The coefficient

on absolute earnings surprise is 0.471 and significant at the 1% level, suggesting that large earnings surprises tend to generate a higher attention response. We find the number of same-day earnings announcements to be negatively related to the attention an earnings announcement receives (the coefficient for number of earnings announcements is -0.0134 and significant at 1% level). This is consistent with Hirshleifer, Lim, and Teoh (2013), who argue that confounding earnings announcements distract investors and lowers the attention allocated to each announcement. The coefficient on book-to-market is negative but not significant.

In Column (2), we include the macro news dummy. The coefficient on the macro news announcement day dummy is -0.0223 and significant at 5% level. This is consistent with the finding in Table 7 that an earnings announcement generates less investor attention when it is announced on the same day as macro news. In Column (3), we interact the macro news day dummy with the large firm dummy. The coefficient is 0.013 but insignificant, suggesting that there is no significant difference in the attenuation effect between large firms and small firms.

5.5 Attention allocation and trading volume

In this section, we test the implications of endogenous attention allocation on trading volume. If macro news distracts investors' attention to a firm's earnings announcements, we should expect a lower trading volume response on macro news days. We test this hypothesis by comparing trading volume on earnings announcement days with and without macro news announcements.

The results are shown in Table 12. We find that the abnormal daily turnover ratio is 0.0203 for earnings announcement days without macro news, but it falls by about 10% to 0.0181 for announcement days with macro news. The difference is 0.0022 and is significant at the 1% level.

To further control for the magnitude of earning surprises, we sort firm-day observations into deciles according to the magnitude of the earnings surprise, and then compare abnormal trading volume for macro news days and non-macro news days within each surprise decile. The results show that, for all deciles, the volume responses to earnings announcements are smaller when there is confounding macro news. The

differences are significant for five out of the ten groups: the most negative earnings surprise group and all of the positive earnings surprise groups.

As shown in the VAR analysis in Table 5, investor attention is an important factor that drives volume changes. The volume evidence from Table 12 thus supports the attention allocation results in Table 8, suggesting that investors rationally allocate their limited attention across various sources of information, process the information, and conduct trading accordingly.

6. Conclusion

This paper studies investor attention and its determinants. We find that investor attention shows a strong seasonality pattern; it is lower on Fridays and during summer months. Investor attention rises when there is firm-specific or macro level news, suggesting that investors react to information shocks by increasing their attention and actively processing information to update their beliefs about firm prospects. The effect is stronger for large firms. We also document evidence that investors strategically allocate their limited attention. When market-wide information shocks and firm-specific information shocks occur simultaneously, investors shift their attention away from firm-specific information. Furthermore, multiple earnings announcements on the same day distract investors and result in lower attention to each announcement. Lastly, trading volume on earnings announcement days is significantly lower when there is a concurrent macro news release. These results confirm the predictions of investor attention models and the implicit assumptions made by previous empirical work on investor attention. It suggests that investors actively manage the level of attention that they pay to the stock market, allocate their attention strategically to process information, and trade accordingly. It would be interesting to extend the analysis in the future to examine the asset pricing implications of attention allocation.

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Figure 1: AbnAttention to American International Group Inc.(AIG)

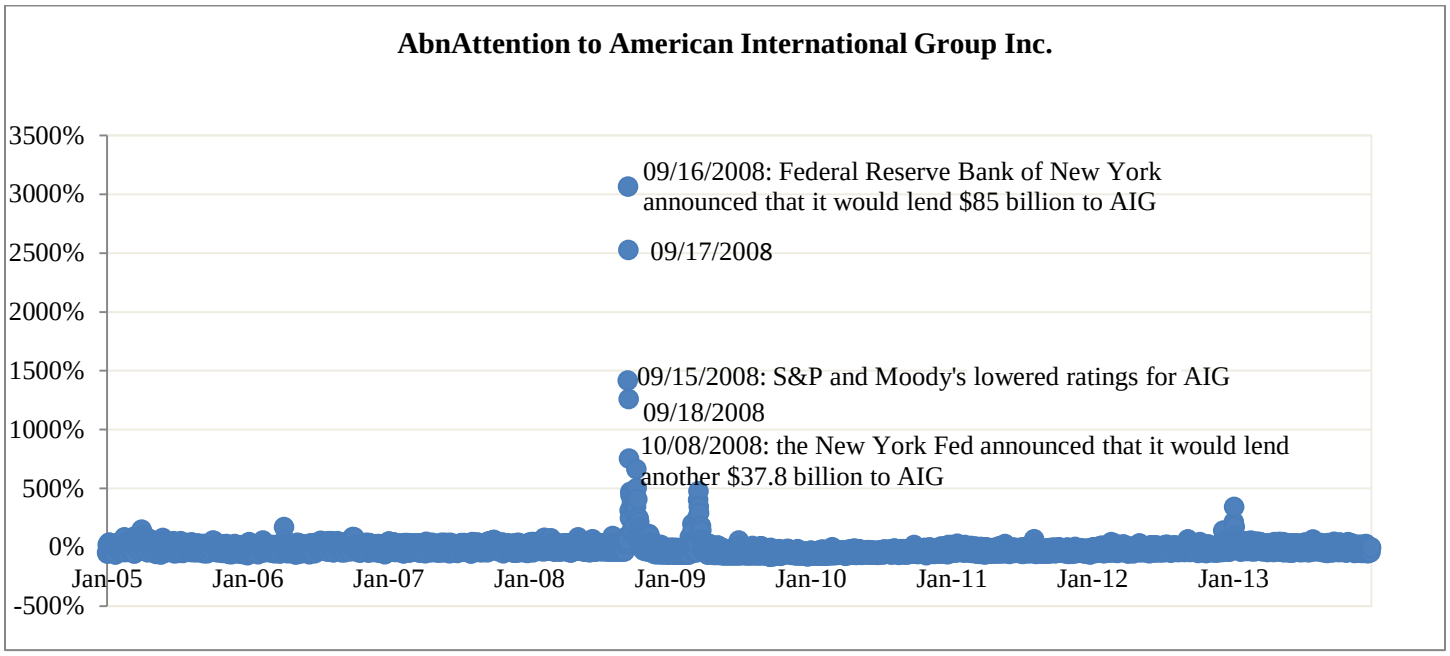

Figure 2: AbnAttention to Apple Inc.(AAPL)

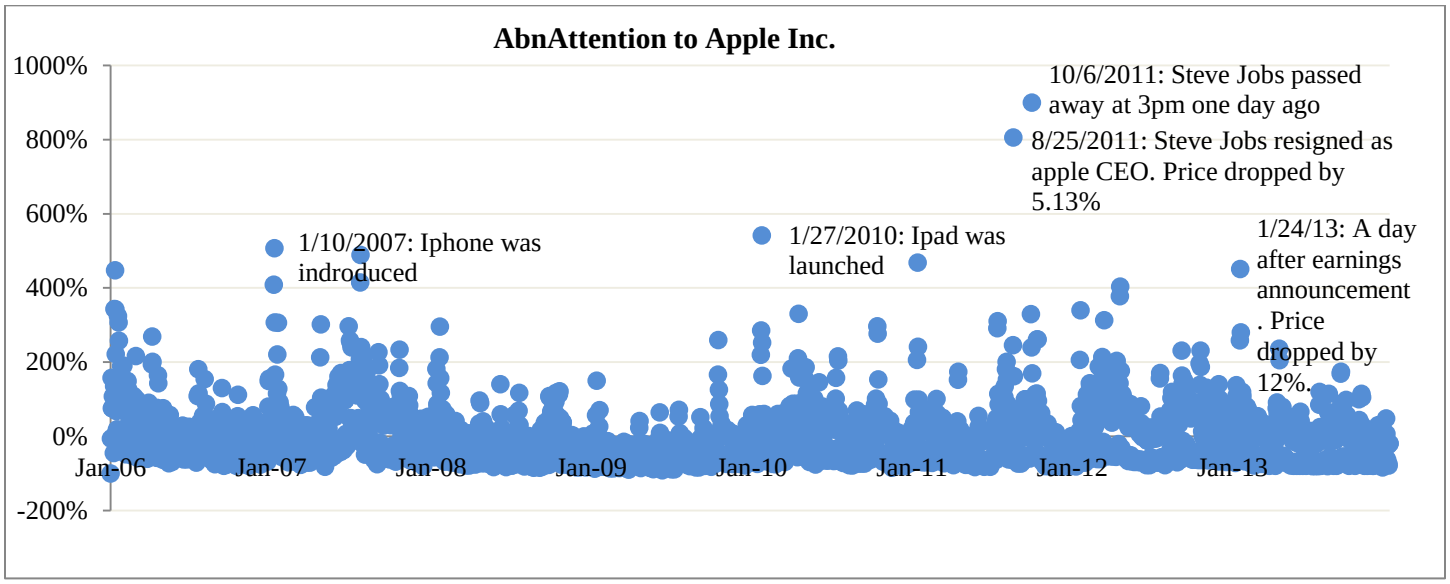

Figure 3: Attention patterns: day-of-week effect

AbnAttention on each day of week is calculated as the mean (median) AbnAttention of all firm-days on that day of week. The precise numbers in this figure are presented in Table 3. In testing the difference in mean, standard errors are adjusted for heteroskedasticity and clustered by date. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Difference in mean test
DIF(Friday-other weekdays)=-2.59%***

Difference in median test
p-value=0.0000

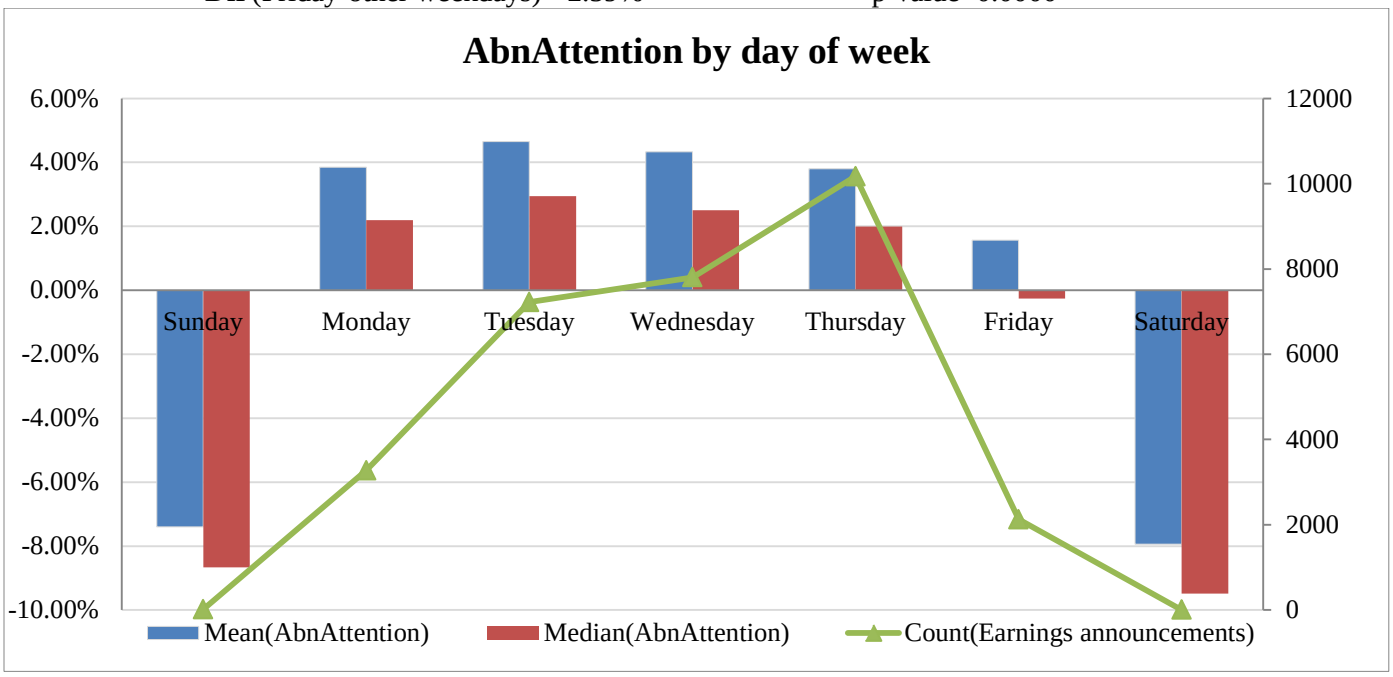

Figure 4: Attention response to earnings announcements: day-of-week effect

In this figure, we present mean (median) AbnAttention on firm-days with an earnings announcement by day of week. For each earnings announcement, we record the AbnAttention on the first trading day after the announcement. The precise numbers in this figure are presented in Table 3. In testing the difference in mean, standard errors are adjusted for heteroskedasticity and clustered by date. ∗, ∗∗, ∗∗∗ indicate significance at the 10%, 5%, and 1% level, respectively.

Difference in mean test
DIF(Friday-other weekdays)=-3.70%***

Difference in median test
p-value=0.0000

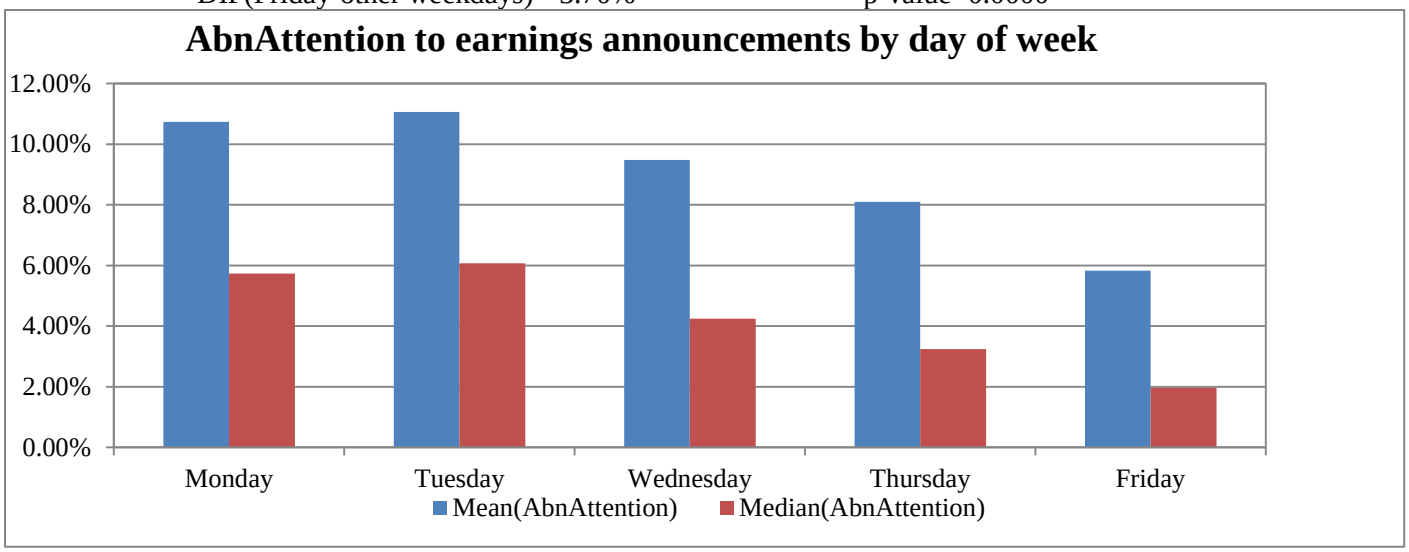

Figure 5: Attention patterns: month-of-year effect

AbnAttention in each month of year is calculated as the mean (median) AbnAttention of all firm-days in that month of year. The precise numbers in this figure are presented in Table 4. In testing the difference in mean, standard errors are adjusted for heteroskedasticity and clustered by date. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Difference in mean test
DIF(Summer-other months)=-0.757%***

Difference in median test
p-value=0.0000

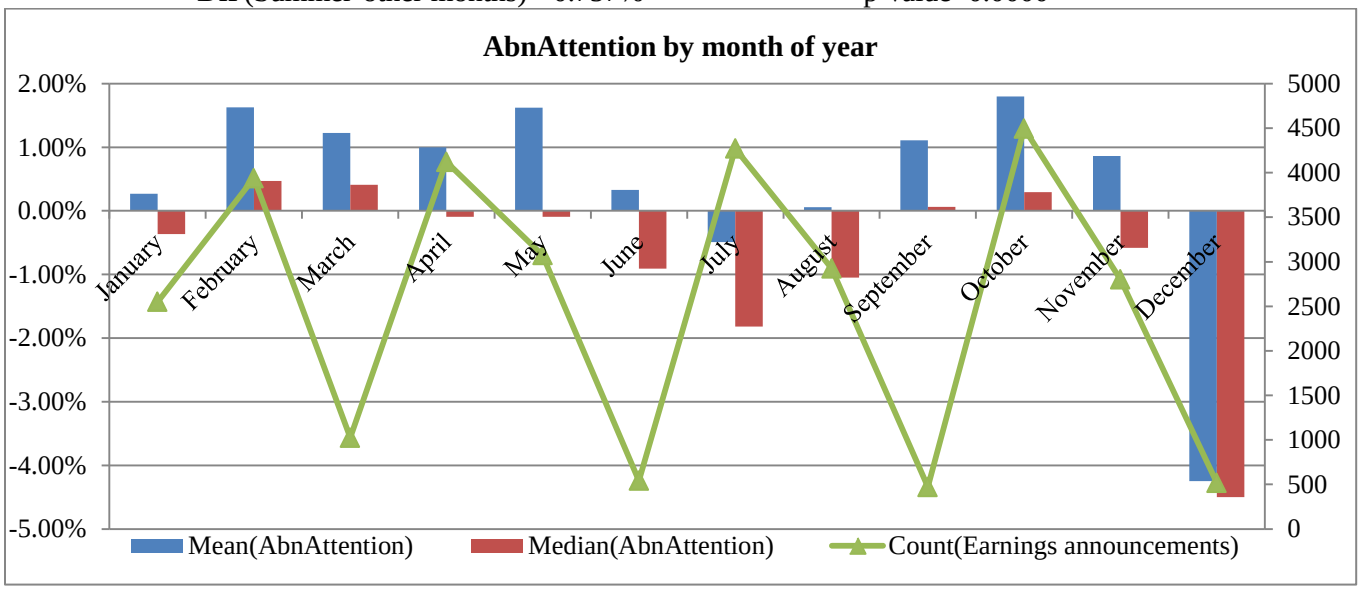

Figure 6: Attention response to earnings announcements: month of the year effect

In this figure, we present mean (median) AbnAttention on firm-days with earnings announcements by month of year. For each earnings announcement, we record the AbnAttention on the first trading day after the announcement. The precise numbers in this figure are presented in Table 4. In testing the difference in mean, standard errors are adjusted for heteroskedasticity and clustered by date. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Difference in mean test
DIF(Summer-other months)=-1.82%***

Difference in median test
p-value=0.0000

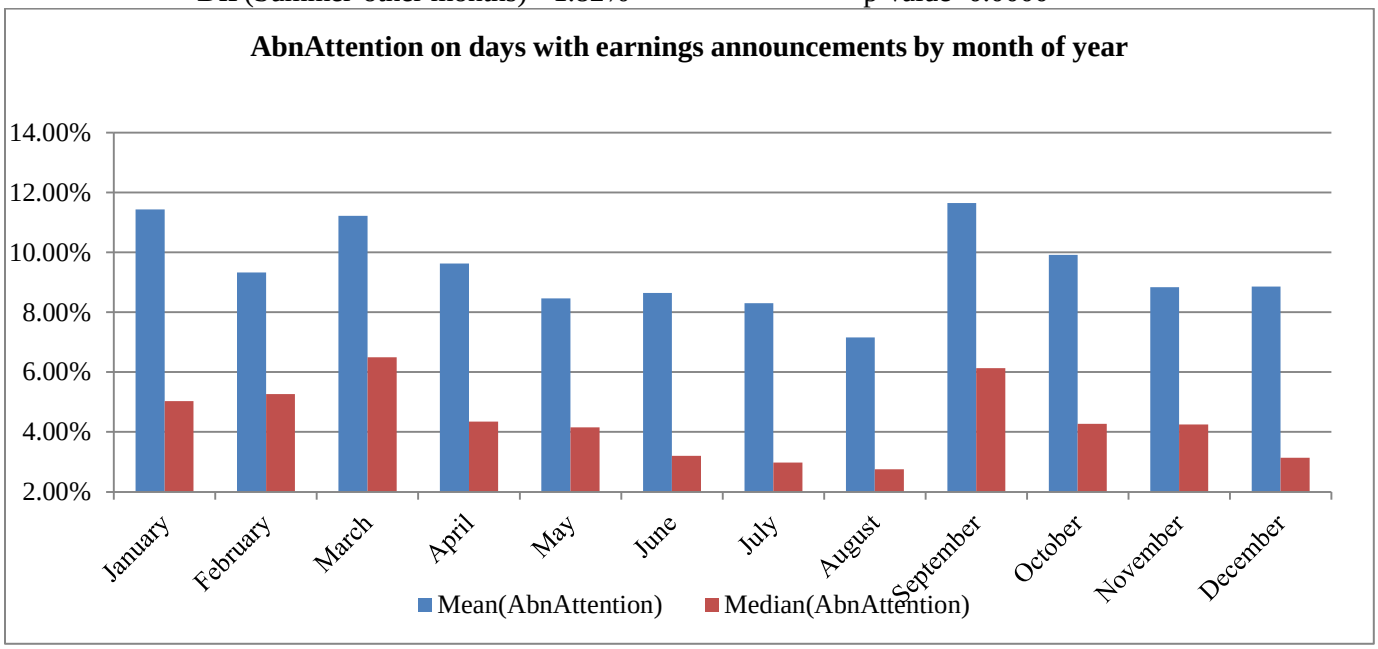

Table 1: Sample description

This table presents the number of firms that are included in the S&P 500, S&P 400, and S&P 600 for the period of 2004-2013, and the number of firms that remain in our final sample.

	S&P 500 firms	S&P400 firms	S&P600 firms	Total
Total number of S&P from 2004-2013	707	590	953	2250
Number of firms in our sample	516	369	431	1316
Number of firms relative to S&P	73%	63%	45%	58.5%

Table 2: Summary statistics

This table presents descriptive statistics for *AbnAttention*. The sample consists of 2,818,625 firm-day observations for 1,316 firms. Variable definitions are provided in the appendix 1. *AbnAttention* is winsorized at the 0.1% and 99.9% level.

	Count	Mean	SD	P10	P25	P50	P75	P90
AbnAttention (%)	2818625	0.41	28.75	-29.32	-14.43	-0.67	12.95	28.68

Table 3: Abnormal attention patterns: day-of-week

This table summarizes the day-of-week patterns of abnormal attention, *AbnAttention*. Panel A presents the mean and median *AbnAttention* and total number of earnings announcements. Panel B presents the mean and median *AbnAttention* for firm-weekdays with earnings announcements. Panel C compares the mean and median *AbnAttention* on days with and without earnings announcements for the same day of week. In testing the differences in means, standard errors are adjusted for heteroskedasticity and clustered by date. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Panel A: Average *AbnAttention*

Day of week	Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.	Mon., Tues, Wed., and Thurs.	DIF(Fri.-Other weekdays)
Mean(AbnAttention)	-7.40%	3.85%	4.65%	4.33%	3.80%	1.57%	-7.94%	4.16%	-2.59%***
Median(AbnAttention)	-8.67%	2.19%	2.95%	2.51%	1.99%	-0.26%	-9.48%	2.41%	-2.67%***
Number of earnings announcements	18	3272	7222	7803	10172	2126	5		

Panel B: *AbnAttention* to earnings announcements

Day of week	Mon.	Tues.	Wed.	Thurs.	Fri.	Mon- Thurs.	DIF(Fri.-Other weekdays)
Mean(AbnAttention)	10.74%	11.06%	9.49%	8.10%	5.83%	9.53%	-3.70%***
Median(AbnAttention)	5.73%	6.07%	4.25%	3.24%	1.97%	4.47%	-2.5%***

Panel C: *AbnAttention* on days with versus without earnings announcements

Earnings announcement day	Mon.	Tues.	Wed.	Thurs.	Fri.	Mon-Thurs.	DIF(Fri.-Other weekdays)
YES	10.74%	11.06%	9.49%	8.10%	5.83%		
NO	3.80%	4.55%	4.24%	3.69%	1.55%		
DIF(YES-NO)	6.93%***	6.52%***	5.25%***	4.41%***	4.28%***	5.78%***	-1.18%*

Table 4: Abnormal attention patterns: month of year effect

In Panel A, we present AbnAttention and total number of earnings announcements by month of year. AbnAttention in each month of year is the mean (median) of all firm-days in that month of year. In Panel B, we present mean (median) AbnAttention on firm-days with earnings announcements by month of year. In Panel C, we compare AbnAttention on days with and without earnings by month of year. In testing the differences in means, standard errors are adjusted for heteroskedasticity and clustered by date. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Panel A: AbnAttention by month of year

Month of year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	DIF(July&Aug.-other months)
Mean(AbnAttention)	0.27%	1.63%	1.23%	1.00%	1.62%	0.33%	-0.49%	0.06%	1.11%	1.80%	0.86%	-4.25%	-0.757%***
Median(AbnAttention)	-0.36%	0.47%	0.41%	-0.09%	-0.09%	-0.91%	-1.82%	-1.05%	0.06%	0.29%	-0.58%	-4.50%	-1.931%***
Number of earnings announcements	2551	3939	1025	4122	3074	541	4271	2925	471	4495	2801	518	

Panel B: AbnAttention to earnings announcements by month of year

Month of year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	DIF(July&Aug.-other months)
Mean(AbnAttention)	11.44%	9.32%	11.22%	9.63%	8.47%	8.64%	8.30%	7.15%	11.65%	9.91%	8.84%	8.85%	-1.82%***
Median(AbnAttention)	5.03%	5.27%	6.49%	4.35%	4.15%	3.20%	2.98%	2.75%	6.13%	4.28%	4.25%	3.14%	-1.76%***

Panel C: Comparison of AbnAttention on days with and without earnings announcements by month of year

Earnings announcement day	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.	DIF(July&Aug.-other months)
YES	11.44%	9.32%	11.22%	9.63%	8.47%	8.64%	8.30%	7.15%	11.65%	9.91%	8.84%	8.85%	
NO	0.15%	1.49%	1.19%	0.85%	1.54%	0.30%	-0.65%	-0.03%	1.09%	1.64%	0.77%	-4.27%	
DIF(YES-NO)	11.3%***	7.83%***	10.0%***	8.77%***	6.93%***	8.34%***	8.94%***	7.18%***	10.6%***	8.27%***	8.07%***	13.1%***	-1.03%*

Table 5: Vector Autoregression (VAR) model of attention, turnover, return, and absolute return

In this table, we run vector autoregression models of *AbnAttention*, abnormal turnover, return, and absolute return. The variables are defined in Appendix 1. We first run VAR for each stock, and then the coefficients are averaged across stocks. The standard errors of coefficients are calculated using block bootstrap at the stock level replaced 5000 times, and the p-value is then calculated under the normal distribution assumption. In Panel A, we run the model with raw return, and absolute raw return. In Panel B, we run the model with abnormal return, and absolute abnormal return.

Panel A: AbnAttention, AbnTurnover, raw return, and absolute raw return

		AbnAttention	AbnTurnover	Raw return	Absolute raw return
AbnAttention	Lag 1	0.363***	0.0004***	-0.00005	0.0006***
	Lag 2	0.0793***	-0.0001	-0.0005***	0.0001
	Lag 3	0.0535***	-0.00003	-0.00003	0.00003
	Lag 4	0.1053***	0.00003	0.0002	0.0003
AbnTurnover	Lag 1	-0.5775	0.3606***	0.0348***	0.1066***
	Lag 2	-0.0627	0.0947***	-0.001	-0.0517***
	Lag 3	0.6459	0.0707***	-0.025***	-0.0831***
	Lag 4	0.2495	0.0737***	-0.0193***	-0.004
Raw return	Lag 1	0.1292	-0.0089***	-0.0474***	-0.0404***
	Lag 2	0.2811***	-0.0043***	-0.0274***	-0.0351***
	Lag 3	-0.0659	-0.0035***	-0.0197***	-0.0284***
	Lag 4	0.0871	-0.003***	-0.0236***	-0.0241***
Absolute raw return	Lag 1	-0.0034	0.0148***	0.0183***	0.1138***
	Lag 2	-0.4331	-0.0072***	0.0122***	0.1209***
	Lag 3	-0.249	-0.0079***	0.0315***	0.111***
	Lag 4	-0.3242*	-0.0111***	0.0121***	0.1011***

Panel B: AbnAttention, AbnTurnover, abnormal return, and absolute abnormal return

		AbnAttention	AbnTurnover	Abnormal return	Absolute abnormal return
AbnAttention	Lag 1	0.3627***	0.0004***	0.0001	0.0007***
	Lag 2	0.0795***	-0.0001	0.0001	-0.00001
	Lag 3	0.0536***	-0.00002	-0.0001	0.0001
	Lag 4	0.105***	0.00003	0.0000	0.0001
AbnTurnover	Lag 1	-0.6845	0.3643***	0.0331***	0.1282***
	Lag 2	-0.2202	0.098***	0.0092	-0.0199*
	Lag 3	0.7952	0.0739***	0.005	-0.0588***
	Lag 4	0.4685*	0.0747***	-0.0121***	-0.0195***
Abnormal return	Lag 1	0.1373	-0.0029***	-0.0214***	-0.0064***
	Lag 2	0.0184	-0.0022***	-0.0156***	-0.0077***
	Lag 3	-0.0165	-0.002***	-0.0164***	-0.0113***
	Lag 4	0.1317	-0.0012	-0.0138***	-0.0099***
Absolute abnormal return	Lag 1	0.0814	0.0158***	0.0006	0.1076***
	Lag 2	-0.2398	-0.0125***	0.0047*	0.0809***
	Lag 3	-0.4093*	-0.0106***	0.0085***	0.0783***
	Lag 4	-0.4381**	-0.0095***	0.0116***	0.0708***

Table 6: Attention responses to earnings announcements

In this table, we compare investors' AbnAttention on firm-days with and without earnings announcements. Weekends are excluded. In Panel A, we report the result for the full sample. In Panel B, we sort firms into five size groups in each June based on NYSE breakpoints. Standard errors are in parentheses. In testing the differences in means, standard errors are adjusted for heteroskedasticity and clustered by date. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Panel A: Full sample

Earnings announcement day	Count	Mean	SD	P25	Median	P75
YES	30595	9.28%	34.78%	-7.78%	4.28%	18.21%
NO	1982265	3.56%	27.07%	-10.25%	1.81%	14.67%
DIF(YES-NO)		5.72%***				

Panel B: By size

	Size group: NYSE breakpoints					
Earnings announcement day	1(Smallest)	2	3	4	5(Largest)	DIF(5-1)
YES	4.405%	5.807%	4.969%	7.677%	19.708%	
	(0.0039)	(0.0036)	(0.0034)	(0.0037)	(0.0057)	
NO	3.089%	3.138%	2.938%	3.889%	4.329%	
	(0.0005)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	
DIF(YES-NO)	1.32%***	2.67%***	2.03%***	3.79%***	15.4%***	14.1%***

Table 7: Attention responses to macro news

In this table, we compare investors' average attention on firm-days with macro news announcements and firm-days without macro news announcements. Weekends are excluded. In Panel A, we report the result for the full sample. In Panel B, we sort firms into five size groups in each June based on NYSE breakpoints. Standard errors are in parentheses. In testing the differences in means, standard errors are adjusted for heteroskedasticity and clustered by date. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Panel A: Full sample

Macro news announcement day	Count	Mean	SD	P25	Median	P75
YES	1422951	3.86%	26.96%	-9.97%	1.96%	14.74%
NO	589909	3.12%	27.71%	-10.85%	1.59%	14.68%
DIF(YES-NO)		0.74%***				

Panel B: By size

Macro news announcement day	Size group: NYSE breakpoints					
	1(Smallest)	2	3	4	5(Largest)	DIF(5-1)
YES	3.24%	3.28%	3.15%	4.11%	4.98%	
	(0.0006)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	
NO	2.80%	2.93%	2.53%	3.55%	3.50%	
	(0.0009)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	
DIF(YES-NO)	0.436%**	0.35%	0.615%***	0.563%**	1.48%***	1.04%***

Table 8: Attention response to earnings announcements, the effect of macro news

In this table, we compare investors' AbnAttention to earnings announcements on firm-days with and without macro news. In Panel A, we report the result for the full sample. In Panel B, we sort firms into five size groups in each June based on NYSE breakpoints. Standard errors are in parentheses. In testing the differences in means, standard errors are adjusted for heteroskedasticity and clustered by date. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Panel A: Full sample

Macro news announcement day	Count	Mean	SD	P25	Median	P75
YES Macro	24798	8.97%	34.69%	-7.98%	4.04%	17.89%
NO Macro	5820	10.56%	35.10%	-6.91%	5.43%	19.42%
DIF(YES-NO)		-1.59%**				

Panel B: By size

	Size group: NYSE breakpoints					
Macro news announcement day	1(Smallest)	2	3	4	5(Largest)	DIF(5-1)
YES Macro	4.766%	8.805%	6.258%	9.242%	20.776%	
	(0.008)	(0.009)	(0.008)	(0.009)	(0.013)	
NO Macro	4.316%	5.139%	4.682%	7.313%	19.453%	
	(0.004)	(0.004)	(0.004)	(0.004)	(0.006)	
DIF(YES-NO)	-0.45%	-3.67%***	-1.58%	-1.93%	-1.32%	-0.87%

Table 9: Attention response to earnings announcements, the effect of important macro news

In this table, we compare investors' AbnAttention to earnings announcements on days with five of the most important macro news with days without any macro announcements. In Panel A, we report the result for the full sample. In Panel B, we sort firms into five size groups in each June based on NYSE breakpoints. The p-values are calculated using standard errors adjusted for heteroskedasticity and clustered by date. ∗, ∗∗, ∗∗∗ indicate significance at the 10%, 5%, and 1% level, respectively.

Panel A: Full sample

Important macro news day	Count	Mean	SD	P25	Median	P75
YES Macro	14187	8.12%	33.89%	-8.47%	3.40%	16.93%
NO Macro	5820	10.56%	35.10%	-6.91%	5.43%	19.42%
DIF(YES-NO)		-2.44%***				

Panel B: By size

	Size group: NYSE breakpoints					
Important macro news day	1(Smallest)	2	3	4	5(Largest)	DIF(5-1)
YES Macro	4.135%	4.934%	4.370%	6.205%	17.893%	
	(0.0055)	(0.0051)	(0.0053)	(0.0051)	(0.0083)	
NO Macro	4.766%	8.805%	6.258%	9.242%	20.776%	
	(0.0081)	(0.0092)	(0.0075)	(0.0094)	(0.0132)	
DIF(YES-NO)	-0.63%	-3.87%***	-1.89*	-3.04%***	-2.88%*	-2.25%

Table 10: Regression analysis: the determinants of abnormal attention

This table presents regression analyses of investors' attention. The dependent variable, $LogAttention_{i,t}$ is the logarithmic transformation of *1+AbnAttention*. $I_{i,t}^{earnings}$ is a dummy variable that equals to one when there is an earnings announcement for firm *i* on day *t* and zero otherwise, and $I_{i,t}^{macro}$ is a dummy that equals to one when there is macro news announcement on day *t* and zero otherwise. I_{large} is a dummy variable that equals to one when the firm in in the largest size quintile, and 0 otherwise. Detailed variables are summarized in Appendix 1. P-values are calculated using robust standard errors clustered by firm and by day, in parentheses. *, **, and ***represent significance at 10%, 5%, and 1% level, respectively. The sample period is from January 2005 to December 2013.

	Dependent variable: *LogAttention*						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$I^{earnings}$	0.126***		0.204***	0.0927***	0.0939***	0.174***	0.117***
	(0.000)		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
I^{macro}		0.119***	0.119***	0.0254***	0.0255***	0.110***	0.0618***
		(0.000)	(0.000)	(0.007)	(0.007)	(0.000)	(0.000)
$I^{earnings} * I^{macro}$			-0.142***	-0.0442***	-0.0450***	-0.136***	-0.0970***
			(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
I_{large}						-0.0248	-0.0249
						(0.117)	(0.116)
$I^{earnings} * I_{large}$						0.132***	0.133***
						(0.000)	(0.000)
$I^{macro} * I_{large}$						0.0368***	0.0368***
						(0.002)	(0.002)
$I^{earnings} * I^{macro} * I_{large}$						-0.0303	-0.028
						(0.130)	(0.164)
Ln(Size)					0.00217		
					(0.513)		
B/M					-0.00048		-0.00066
					(0.753)		(0.674)
Day of week fixed effect	NO	NO	NO	YES	YES	NO	YES
Month fixed effect	NO	NO	NO	YES	YES	NO	YES

Table 11: Regression Analysis of Attention response to earnings announcements

This table analyzes the determinants of investors' attention to earnings announcements. The sample includes 27,337 quarterly earnings announcements. The dependent variable in each regression is (Ln (AbnAttention+1)). Variables are defined in Appendix 1. P-values are calculated using robust standard errors clustered by firm and by day, in parentheses. For each earnings announcement, we record the AbnAttention on the first trading day after the announcement. *, **, and ***represent significance at 10%, 5%, and 1% level, respectively. The sample period is from January 2005 to December 2013.

Dependent variable: ln(1+AbnAttention)			
	(1)	(2)	(3)
Macro news announcement day		-0.0223***	-0.0271***
		(0.009)	(0.008)
Large firms			0.0743***
			(0.000)
Macro news day*Large firm			0.013
			(0.409)
Ln(Size)	0.0365***	0.0364***	
	(0.000)	(0.000)	
Absolute earnings surprise	0.471***	0.472***	0.401***
	(0.000)	(0.000)	(0.000)
Ln(# of earnings announcement)	-0.0134**	-0.0122*	-0.0125*
	(0.036)	(0.059)	(0.062)
Ln(1+ of analyst following)	0.0180**	0.0181**	0.0372***
	(0.022)	(0.021)	(0.000)
Book/Market	-0.0111	-0.0107	-0.0207*
	(0.371)	(0.387)	(0.097)
Day of week fixed effect	YES	YES	YES
Month fixed effect	YES	YES	YES

Table 12: Trading volumes on earnings announcement days with and without macro news announcements

In this table, we compare trading volume on earnings announcement days with and without macro news announcements. Each quarter, we group earnings announcements in each earnings surprise decile into those that are announced on days with macro news and those that are not. We then calculate average daily *AbnTurnover* ($x10^{-2}$) for each group and take the time-series average. To test if the difference in mean is significantly smaller than zero, we calculate the time-series average and standard errors of differences between the two groups in each quarter. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Macro news announcement day	Total	1(Smallest)	2	3	4	5	6	7	8	9	10(Largest)
YES	1.81	2.55	1.91	1.73	1.49	1.48	1.57	1.59	1.54	1.79	2.53
NO	2.03	2.98	1.99	1.85	1.57	1.50	1.81	2.04	1.78	2.07	2.86
DIF(mean)	-0.22***	-0.43**	-0.08	-0.12	-0.08	-0.03	-0.24*	-0.45**	-0.24**	-0.27*	-0.33*

Appendix 1: Variable definition

SVI	A term's likelihood of being searched on a day scaled by the highest daily likelihood over the period the user specifies, multiplied by 100
AbnAttention	The difference between daily SVI and the average SVI from day -360 to day -31scaled by the average.
LogAttention1	Logarithm of AbnAttention plus one
AbnTurnover	Difference between turnover on day t and average turnover from day t-255 to day t-21.
Earnings surprise	(Actual EPS-Median forecasted EPS in 90 days prior to the announcement)/Fiscal quarter end stock price
Absolute earnings surprise	Absolute value of earnings surprise
Earnings announcement day	A dummy variable that equals to one if there is an earnings announcement on a firm-day and zero otherwise
Macro news announcement day	A dummy variable that equals to one if there is at least one macro news announcement on a firm-day and zero otherwise
Large firm	A dummy variable that equals to one if a firm is in the top size quintile according to NYSE breakpoints and zero if a firm is in the bottom size quintile. Portfolio formed at the end of each June.
Size	Market capitalization calculated at the end of each June
Log(size)	Natural logarithm of market capitalization.
Log(1+# of analyst following)	Natural logarithm of number of analysts that forecasted the quarterly earnings 90 days prior to the actual announcement day.
Log(# of earnings announcements)	Natural logarithm of number of earnings announcements recorded in I/B/E/S on a day. After-hour or holiday earnings announcements are counted in the following trading day
Return	Stock return
Abnormal return	Characteristic (5*5 book-to-market and size) adjusted return.
Price volatility	Absolute daily raw return or abnormal return
Book/Market	Book to market ratio. Book value calculated in each December and Market value calculated in each June.

Appendix 2: U.S. News Announcements

Announcement	Obs	Start date	End date	Time	Relevance	Day
Quarterly Announcements						
GDP Advance	40	1/30/2004	11/7/2013	8:30	96.61	Around 27th of the Jan, April, July, Oct
GDP Preliminary	40	2/27/2004	12/5/2013	8:30	96.61	Around 29th of Feb, May, Aug, Nov
GDP Final	39	3/25/2004	12/20/2013	8:30	96.61	Around 28th of March, June, Sep, Dec
Personal Consumption Advance	40	1/30/2004	11/7/2013	8:30	67.63	Around 27th of the Jan, April, July, Oct
Personal Consumption Preliminary	40	2/27/2004	12/5/2013	8:30	67.63	Around 29th of Feb, May, Aug, Nov
Personal Consumption Final	39	3/25/2004	12/20/2013	8:30	67.63	Around 28th of March, June, Sep, Dec
Monthly Announcements						
Nonfarm Payrolls	120	1/9/2004	12/6/2013	8:30	99.15	First Friday of the month
ISM Manufacturing	120	1/2/2004	12/2/2013	10:00	95.76	1st business day of the month
Consumer Confidence Index	119	1/27/2004	12/31/2013	10:00	94.92	Around 25h of the month
Consumer Price Index	119	1/15/2004	12/17/2013	8:30	93.22	Around 16th of the month
Durable Goods Orders	119	1/28/2004	12/24/2013	8:30	91.53	Around 26th of the month
New Home Sales	118	2/26/2004	12/24/2013	10:00	90.68	17th workday of the month
Retail Sales	119	1/15/2004	12/12/2013	8:30	89.83	Around the 12th of the month
Unemployment Rate	120	1/9/2004	12/6/2013	8:30	89.24	First Friday of the month
Housing Starts	119	1/21/2004	12/18/2013	8:30	88.98	2nd or 3rd week after the reporting month
Existing Home Sales	106	2/25/2005	12/19/2013	10:00	88.14	Around the 25th of the month
Industrial Production	119	1/16/2004	12/16/2013	9:15	87.29	Around the 15th of the month
Factory Orders	120	1/6/2004	12/5/2013	10:00	85.59	Around the first business day of the month
Personal Income	119	2/2/2004	12/23/2013	8:30	84.75	Around the 1st business day of the month
Personal Spending	119	2/2/2004	12/23/2013	8:30	84.75	Around the first or last business day of the month
Producer Price Index	119	1/14/2004	12/13/2013	8:30	83.90	3rd week of each month
Leading Index	119	1/22/2004	12/19/2013	10:00	83.05	Around the first business day of the month
Trade Balance	120	1/14/2004	12/4/2013	8:30	82.20	Around the 20th of the month
Construction Spending	120	1/5/2004	12/2/2013	10:00	77.97	Around 1st/2nd of the month
Monthly Budget Statement	120	1/15/2004	12/11/2013	Varying	74.58	Around the third week of the month for the prior month
ISM Non-Manufacture Composite	71	2/5/2008	12/4/2013	10:00	73.73	3rd business day of the month
Building Permits	119	1/21/2004	12/18/2013	8:30	62.29	18th workday of the month
Capacity Utilization	119	1/16/2004	12/16/2013	9:15	61.10	Around 15th/16th of the month
Consumer Credit	120	1/8/2004	12/6/2013	15:00	38.98	Around 5th business day of the month
Business Inventories	119	1/16/2004	12/12/2013	8:30/10:00	36.44	Around the 15th of the month
Weekly announcements						
Initial Jobless Claims	518	1/8/2004	12/26/2013	8:30	98.31	Each Thursday
Money Stock	510	1/2/2004	12/26/2013	16:30	NA	Each Thursday
Six week announcements						
FOMC Rate Decision	81	1/28/2004	12/18/2013	NA	97.46	at least 8 times a year

Appendix 3: *AbnAttention* on days with and without earnings announcement, excluding weekends and macro announcement days

In this table, we compare investors' average AbnAttention on days with earnings announcements and days without earnings announcements. Firm-days with macro news announcements and weekends are excluded. In Panel A, we report the result for the full sample. In Panel B, we sort firms into five size groups in each June based on NYSE breakpoints. The p-values are calculated using standard errors adjusted for heteroskedasticity and clustered by date. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Panel A: Full sample

Earnings announcement day	Count	Mean	SD	P25	Median	P75
YES	5797	10.57%	35.13%	-6.86%	5.42%	19.42%
NO	584112	3.05%	27.64%	-10.88%	1.56%	14.64%
DIF(YES-NO)		7.52%***				

Panel B: By size

	Size group: NYSE breakpoints					
Earnings announcement day	1(Smallest)	2	3	4	5(Largest)	DIF(5-1)
YES	4.755%	8.841%	6.171%	9.236%	20.840%	
	(0.0081)	(0.0093)	(0.0075)	(0.0094)	(0.0132)	
NO	2.788%	2.882%	2.502%	3.491%	3.350%	
	(0.0009)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	
DIF(YES-NO)	1.97%**	5.96%***	3.67%***	5.74%***	17.5%***	15.5%***

Appendix 4:AbnAttention on days with and without macro news announcement

In this table, we compare investors' average attention on days with macro news announcements and days without macro news announcements. Firm-days with earnings announcements and weekends are excluded. In Panel A, we report the result for the full sample. In Panel B, we sort firms into five size groups in each June based on NYSE breakpoints. The p-values are calculated using standard errors adjusted for heteroskedasticity and clustered by date. *, **, *** indicate significance at the 10%, 5%, and 1% level, respectively.

Panel A: Full sample

Macro news announcement day	Count	Mean	SD	P25	Median	P75
YES	1398153	3.77%	26.82%	-10.01%	1.92%	14.69%
NO	584112	3.05%	27.64%	-10.88%	1.56%	14.64%
DIF(YES-NO)		0.719%***				

Panel B: By size

Macro news announcement day	Size group: NYSE breakpoints					
	1(Smallest)	2	3	4	5(Largest)	DIF(5-1)
YES	3.21%	3.24%	3.12%	4.05%	4.74%	
	(0.0006)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	
NO	2.79%	2.88%	2.50%	3.49%	3.35%	
	(0.0009)	(0.0008)	(0.0008)	(0.0008)	(0.0008)	
DIF(YES-NO)	0.427%**	0.36%	0.618%***	0.564%**	1.39%***	0.961%***