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Limited investor attention and biased reactions to information: Evidence from the COVID-19 pandemic

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ABSTRACT

We find that the COVID-19 pandemic increases (decreases) stock return sensitivity to market-wide (firm-specific) news, which is associated with return reversals (delayed reactions). These results are consistent with limited investor attention and investors paying heightened (reduced) attention to macro (micro) information after the outbreak. There are more biased reactions when the epidemic spread is higher, to good news than bad news, for firms headquartered in pandemic epicenters, and for larger stocks. We also find higher (lower) imbalanced trading, information flow, and price efficiency associated with market-wide (firm-specific) news during the pandemic.

1. Introduction

The psychology literature acknowledges that attention is a scarce cognitive resource (Kahneman, 1973). When making investment decisions, people have to be selective in information processing due to their attention constraints. It requires investors’ close attention for information to be timely incorporated into stock prices, while investors need to allocate their limited attention across various types of information. Therefore, stock market reactions to information could vary with investors’ allocated attention. The Corona Virus Disease 2019 (COVID-19) was first reported in China in December 2019, and the World Health Organization (WHO) soon declared it a Public Health Emergency of International Concern in January 2020 and then a pandemic in March 2020. Shocks of macro-uncertainty influence the underlying channel through which information flows to the market (Williams, 2015). The sudden outbreak of the COVID-19 pandemic not only affected stock market fundamentals but also attracted lots of investor attention. It is an interesting question whether the pandemic influences the market responses to information.

On the one hand, Peng and Xiong (2006) show theoretically that limited attention leads to category-learning behavior (i.e., the tendency of investors to process more market and sector-wide information than firm-specific information). Prior studies largely focus on earnings news and provide evidence of underreaction supporting that less attention is allocated to firm-specific information (e.g., Kottimukkalur, 2019). Given that the pandemic and its evolution are related to macroeconomic fundamentals and the difficulty in processing multiple pieces of information simultaneously, we expect investors to allocate more attention to macro information and get distracted from micro information during the pandemic and such pandemic-induced changes in attention to increase with the epidemic spread. The heightened (reduced) investor attention to macro (micro) information can result in the increased (decreased) market

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reaction to market-wide (firm-specific) news.

On the other hand, abundant empirical evidence supports Samuelson’s dictum that the stock market is micro efficient but macro inefficient (Jung and Shiller, 2005). It is argued that investors’ attention constraints force them to specialize, and many investors may focus on a narrow set of stocks and overlook information aggregated over many stocks. If there exists greater efficiency at the micro level rather than the macro level, the pandemic does not necessarily affect market reactions to information, and it remains an empirical question to understand the information incorporation.

We focus on the U.S. stock market to examine whether and how market reactions to macro and micro information change during the COVID-19 pandemic. The U.S. is one of the countries suffering most from the pandemic, and its number of infections has risen dramatically since March 2020. We consider all stocks in the Center for Research in Security Prices (CRSP) and the macro and firm-specific news data from the RavenPack News Analytics (RPNA). We compare the stock markets before and after the outbreak from January 2019 to December 2020. We document a higher (lower) stock return sensitivity to market-wide (firm-specific) news after the outbreak of the pandemic. It supports our conjecture of investors’ attention constraints and their category-learning behavior (i.e., paying more (less) attention to macro (micro) information during the pandemic). During the post-outbreak period, we examine epidemic spread to capture the exogenous shock to investor attention induced by the pandemic. We find that stock return sensitivity to market-wide (firm-specific) news increases (decreases) with the epidemic spread. Such biased market reactions provide evidence that the pandemic alters investors’ attention allocation to macro and micro information. Moreover, we examine the predictive effects of news on future returns. If the increased (decreased) contemporaneous relationship between market-wide (firm-specific) news and stock returns reflects investors’ overreaction (underreaction) due to their heightened (reduced) attention to macro (micro) information, we expect mispricing correction (delayed reaction) in future returns associated with the market-wide (firm-specific) news. By analyzing stock returns over the next ten days, we observe a negative (positive) predictive effect of market-wide (firm-specific) news during the pandemic, which reveals a complete picture of biased reactions to information.

Using geographical dispersion of firm headquarters locations, we find more biased reactions to information, particularly more increased (reduced) stock return sensitivity to market-wide (firm-specific) news for firms headquartered in states that are identified as pandemic epicenters at different points in time. It suggests that the pandemic affects investors’ attention allocation in a heterogeneous manner, and investors are especially attentive to macro news for firms located in the epicenters, leaving less attention to micro information. We also document more mispricing correction (delayed reaction) associated with macro (micro) information in future returns for firms located in the epicenters, which is in line with investors’ attention constraints and changes in their attention allocation due to the pandemic.

We conduct three additional experiments. First, we consider good and bad news events separately. The psychology literature documents that negative information tends to outweigh positive information in the minds of individuals, which is known as negativity bias (e.g., Baumeister et al., 2001). Investors tend to watch bad news more closely than good news, and their attention to bad news is thus expected to be less vulnerable to exogenous shocks (e.g., Akhtar et al., 2011). By comparing good news and bad news, we document less biased market reactions to bad market-wide and firm-specific news during the pandemic, and it is in line with investors’ negativity bias. Second, we focus on the post-outbreak period and separately consider the positive and negative values of the epidemic spread. If investors have a negativity bias and follow negative COVID-related information more closely, we expect a positive spread to have a more substantial effect in changing their attention allocation than a negative spread. Our analysis shows that a positive spread is associated with more biased stock market reactions to market-wide and firm-specific news. It suggests the pandemic-induced changes in investor attention are more evident in the “out-of-control” situation as expected. Third, we consider large-size and small-size stocks separately according to their market capitalization. When investors pay more attention to the market as a whole, they tend to concentrate on the larger and more visible firms (Drake et al., 2017). We thus expect to see more heightened attention to market-wide news in larger stocks, and consequently, the attention to firm-specific news is more impaired. Consistent with this conjecture, we observe more increased (decreased) reactions to market-wide (firm-specific) news in larger stocks.

To ensure the solidity of our empirical findings, we conduct several robustness tests, including considering an alternative measurement of news variables, extending the pre-outbreak period or both the pre- and post-outbreak periods, adopting alternative dates for the outbreak, modifying our measure of epidemic spread, and adopting alternative return measurement.

To further establish the validity of our evidence, we test for biased market reactions to macro and micro information by examining investors’ trading behavior, information flow to the stock, and stock price efficiency. We show that investors’ imbalanced trading responds more (less) to market-wide (firm-specific) news during the pandemic and their response to market-wide (firm-specific) news increases (reduces) with the epidemic spread, which is consistent with investors having attention constraints and their attention to macro (micro) information is heightened (reduced) during the pandemic. Also, it requires investor attention for information to flow from the news to stock prices. We then investigate how the roles of market-wide and firm-specific news in the information flow are affected by the pandemic. We show that the effect of market-wide news on the information flow is amplified by the outbreak and spread of the virus, whereas the corresponding effect of firm-specific news is rather impaired. We also analyze stock price efficiency. We find that the pandemic outbreak increases the effect of market-wide news on the price efficiency of the stock, whereas the efficiency effect of firm-specific news is considerably reduced. Our results consistently support limited investor attention and changes in attention allocation.

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1 Following WHO’s declaration, we consider the period starting from March 2020 as the pandemic period. In robustness checks, we adopt alternative outbreak dates and obtain qualitatively similar results.

2 The negativity bias may also result from the notion of loss aversion that people care more about a loss in utility than a gain of equal magnitude (Kahneman and Tversky, 1979).
allocation induced by the pandemic, as evidenced by analyzing stock return sensitivity to news. In particular, the increased (decreased) effects of market-wide (firm-specific) news on stock returns, order imbalance, information flow, and stock price efficiency are in line with the heightened (reduced) attention to macro (micro) information under the disturbance of the pandemic.

This paper contributes to the literature examining the implications of limited investor attention. Theoretically, Peng and Xiong (2006) show that limited attention generates category-learning behavior (i.e., the tendency of investors to focus more on macro information than on micro information). Prior studies provide empirical evidence of attention constraints, particularly on the incorporation of earnings news. For instance, Kottimukkalur (2019) documents more post-earnings announcement drifts following large market-moving days, consistent with reduced (heightened) attention paid to firm-specific (market-wide) information. There exists more investor inattention to Friday earnings announcements (DellaVigna and Pollet, 2009), and the processing of earnings news could be affected by weather-induced moods (Dehaan et al., 2017). Hirshleifer and Sheng (2022) and Liu et al. (2022) also study how the arrival of macro news affects the sensitivity of stock prices to earnings news, highlighting the importance of considering clientele effects. In addition, fund managers tend to pick stocks in booms and time the market in recessions, which can be explained by an attention allocation model (Kacperczyk et al., 2014, 2016). Previous studies also use the framework of rational inattention to explain the comovement of stock returns (Peng et al., 2007; Huang et al., 2019). We adopt the COVID-19 pandemic and its evolution to capture changes in investors’ attention allocation and examine how stock return responses to macro and micro information are influenced. We document overreaction (underreaction) to market-wide (firm-specific) news, in line with investors’ limited attention.

Our findings also contribute to the growing literature analyzing stock market dynamics during the COVID-19 pandemic. No previous infectious disease outbreak has affected the stock market as forcefully as COVID-19, where government restrictions on commercial activity and voluntary social distancing exert powerful effects (Baker et al., 2020). Previous studies examine the financial implications of the pandemic by focusing on various aspects, such as the index options (Jackwerth, 2020), the safe-haven assets (Ji et al., 2020), and stock growth expectations (Gormsen and Koijen, 2020). The COVID-19 pandemic presents investors with a complex investment environment, and there is also increasing literature concerning investor behavior during the crisis. For instance, Cookson et al. (2020) explore the heterogeneous beliefs of investors with differential political identity in the wake of the pandemic and their impacts on the stock market. Smales (2020) demonstrates that investor attention to the pandemic increases with the number of newly reported COVID-19 cases, affecting global stock market returns. We take a new perspective from limited investor attention to examine the stock market dynamics during the pandemic. Our findings provide a timely and important contribution to understanding the influence of the pandemic on information incorporation.

The remainder of the paper is structured as follows. The sample and regression variables used in our analysis are introduced in Section 2. In Section 3, we discuss the effects of the COVID-19 pandemic on current and future stock return sensitivities to market-wide and firm-specific news, examine the heterogeneous impact for the firms headquartered in the pandemic epicenters, outline the additional return analysis focusing on good and bad news, positive and negative epidemic spreads, and large-size and small-size stocks, and discuss the robustness checks. In Section 4, we examine imbalanced trading, information flow, and stock price efficiency. We conclude in Section 5.

2. Sample and regression variables

We consider all U.S. stocks in CRSP in our empirical analysis. The COVID-19 pandemic, which started in December 2019, has been engulfing the U.S. since late February 2020. To compare the stock markets before and after the outbreak, we examine the January 2019 to December 2020 period.

2.1. Explanatory variables

To capture the dynamic spread of the COVID-19 in the U.S., we measure it by the number of (daily) new infection cases. These data are available from the Centers for Disease Control and Prevention (CDC). Because the epidemic spread has a strong time-trend over the period, we detrend it by subtracting the seven-day moving average from the raw series, named as \( dSpread \) and adopt it to proxy for the exogenous shock to investor attention. The pandemic-induced changes in investor attention tend to increase with the epidemic spread.

To capture new releases of economic relevance, we collect the data of market-wide (i.e., macro) and firm-specific (i.e., micro) news items from the RPNA database. \(^3\) The Event Sentiment Score (ESS) provided by RPNA ranges between 0 and 100, indicating the capacity of a news item to affect the market price. An ESS greater (smaller) than 50 relates to good (bad) news. For each news item \( k \) on day \( t \), we use \( \text{News}_{k,t} = \frac{\text{ESS}_{k,t} - 50}{50} \) to gauge the information content, which ranges between \(-1\) and \(1\) with a positive (negative) value proxying the amount of positive (negative) information. This definition applies to both macro news and micro news items.

In addition to the ESS, the RNPA also provides the Event Novelty Score (ENS) and Event Relevance Score (ERS), both ranging between 0 and 100, with 100 indicating the most novel and relevant news event. To concentrate on the most novel and relevant news, we only consider the news items with both ENS and ERS reaching 100. Then, we define our macro and firm-specific news variables for trading day \( t \) in the return analysis as the averages over all non-neutral news items:

\(^3\) To collect the macro news items, we focus on the Global Macro package of RPNA for the three entities: United States, United States Federal Reserve, and Government of the United States. Firm-specific news items are collected from the Equities package of RPNA.
where \( n_i \) (\( n_{ij} \)) denotes the number of macro (firm-specific) news events on day \( t \) (for firm \( i \) on day \( t \)) with the ENS and ERS being 100 and ESS different from 50. In further analyses of information flow and price efficiency, we focus on their absolute values, defined as:

\[
|\text{MacroNews}_{ij}| = \frac{1}{n_i} \sum_{k=1}^{n_i} |\text{MacroNews}_{k,i}|;
\]

\[
|\text{MicroNews}_{ij}| = \frac{1}{n_{ij}} \sum_{k=1}^{n_{ij}} |\text{MicroNews}_{k,ij}|.
\]

We adopt a similar approach as in prior studies using the RPNA (e.g., Dang et al., 2015; Bushman et al., 2017). The descriptive statistics of the epidemic spread and the news variables are in Panel A of Table 1.

### 2.2. Dependent variables

To study the stock market reaction to macro and firm-specific news, we focus on the close-to-close returns of individual stocks. That is, for each stock, we have:

\[
\text{Return}_{i,t} = \frac{\text{Close}_{i,t} - \text{Close}_{i,t-1}}{\text{Close}_{i,t-1}},
\]

where \( \text{Close}_{i,t} \) denotes the closing price of stock \( i \) on day \( t \). The daily data of closing prices are sourced from the CRSP.

We also investigate how investors’ trading activities respond to market-wide and firm-specific news. To measure investors’ daily order imbalance, we use:

\[
\text{Imbal}_{i,t} = \frac{\text{Buy}_{i,t} - \text{Sell}_{i,t}}{\text{SharesOutstanding}_{i,t}},
\]

where \( \text{Buy}_{i,t} \) and \( \text{Sell}_{i,t} \) are, respectively, the buyer-initiated and seller-initiated trading volume of stock \( i \) on day \( t \), identified by the Lee and Ready (1991) algorithm with trade and quote data from the Thomson Reuters Ticker History (TRTH). \( \text{SharesOutstanding}_{i,t} \) denotes the stock’s number of shares outstanding.

We also estimate the information flow to stock by quantifying the permanent component of stock price shocks via the decomposition process of Beveridge and Nelson (1981).\(^5\) We use a univariate autoregression (AR) model to conduct the decomposition. For each day, the log return of a stock is regressed at a 1-min frequency with thirty lags:

\[
r_t = \sum_{k=1}^{30} A_k r_{t-k} + e_t,\]

which yields \( \Phi(1) = 1 - \sum_{k=1}^{30} A_k \) and residuals \( \tilde{e}_t \).\(^6\) The intraday data for the estimations is obtained from the TRTH. According to Beveridge and Nelson (1981), \( \Phi(1)^{-1}\tilde{e}_t \) reflects the permanent price shocks and its variance \( \Phi^{-2}\text{Var}(\tilde{e}_t) \) captures the information flow. Thus, we measure daily information flow as:

\[
\text{InfoFlow} = \Phi^{-2}\text{Var}(\tilde{e}_t).
\]

In addition, we construct the stock price efficiency by the absolute value of excess variance ratio of stock returns, which is a combination of return variance at the 1-min and 5-min intervals over the day.\(^7\) The excess variance ratio is an inverse indicator of efficiency, which captures the resemblance of randomness for stock price movements. Therefore, we define our daily efficiency measure as:

\[\text{Efficiency} = \frac{\text{ExVar}_{15s} - \text{ExVar}_{1min}}{\text{ExVar}_{15s}}\]

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\(^4\) News items that occur on a non-trading day are allocated to the next trading day for calculating daily news variables. In robustness tests, we do not exclude neutral news items and obtain qualitatively similar results.

\(^5\) See Hasbrouck (1993), Boehmer and Kelley (2009), and Lee et al. (2016) for similar approaches.

\(^6\) In unreported robustness tests, we apply different time resolution and number of lags and estimate \( \text{InfoFlow} \) by the AR model at the 15-s frequency with ten or sixty lags. Our findings remain robust.

\(^7\) See O’Hara and Ye (2011), Comerton-Forde et al. (2016), and Rösch et al. (2017) for similar measures. In unreported robustness tests, we not only reconstruct the excess variance ratio by the alternative pair of 15-s and 1-min return variances but also introduce a new efficiency measure, which is the absolute value of the return autocorrelation. The daily return autocorrelation of a stock is estimated by the first-order autocorrelation coefficient of 1-min returns over the day. Our findings remain qualitatively similar.
Table 1
Descriptive statistics.
Panel A of this table displays the descriptive statistics of the explanatory variables in our analysis. $MkNews_t$ ($FmNews_{it}$) is the daily measure of market-wide (firm-specific) news calculated by averaging all non-neutral macro (firm-specific) news events released, and $SumMkNews_t$ ($SumFmNews_{it}$) is the alternative daily measure of market-wide (firm-specific) news calculated by summing all non-neutral news events. $dSpread_t$ is the detrended daily spread of COVID-19 infection after the outbreak. Panel B reports the descriptive statistics of the dependent variables. $Return_{it}$, $InfoFlow_{it}$, $Efficiency_{it}$, and $Imbal_{it}$ are the daily measures of stock close-to-close returns, information flow to the stock, stock price efficiency, and stock imbalanced trading, respectively. Panel C reports the descriptive statistics of control variables, including change in the market volatility index $\Delta VIX_t$, stock market capitalization in trillions $Capit_{it}$, Amihud’s (2002) stock illiquidity ratio $Illiq_{it}$, and stock realized volatility of 1-min returns $Volat_{it}$. Panel D reports the correlations of all variables. The sample period is from January 2019 to December 2020 except for $dSpread_t$, which is based on the period from February 29 to December 31, 2020.

### Panel A: Descriptive statistics of the explanatory variables

|                  | $MkNews_t$ | $FmNews_{it}$ | $SumMkNews_t$ | $SumFmNews_{it}$ | $dSpread_t$ |
|------------------|------------|---------------|---------------|-----------------|-------------|
| Mean             | −0.038     | 0.043         | −0.215        | 0.271           | 1688.26     |
| Median           | −0.029     | 0.046         | −0.170        | 0.290           | 1183.50     |
| Max              | 0.900      | 0.950         | 9.530         | 8.860           | 47,581.00   |
| Min              | −0.780     | −1.000        | −7.760        | −8.020          | −48451.00   |
| Std. Dev.        | 0.185      | 0.235         | 1.148         | 1.463           | 9240.81     |

### Panel B: Descriptive statistics of the dependent variables

|                  | $Return_{it}$ | $InfoFlow_{it}$ | $Efficiency_{it}$ | $Imbal_{it}$ |
|------------------|---------------|-----------------|-------------------|-------------|
| Mean             | 0.000         | 0.003           | −0.003            | 0.005       |
| Median           | 0.000         | 0.002           | −0.003            | 0.004       |
| Max              | 0.109         | 0.038           | 0.000             | 0.267       |
| Min              | −0.219        | 0.000           | −0.011            | −0.105      |
| Std. Dev.        | 0.013         | 0.003           | 0.002             | 0.016       |

### Panel C: Descriptive statistics of the control variables

|                  | $\Delta VIX_t$ | $Capit_{it}$ | $Illiq_{it}$ | $Volat_{it}$ |
|------------------|---------------|--------------|-------------|-------------|
| Mean             | −0.005        | 0.016        | 1.055       | 0.088       |
| Median           | −0.170        | 0.003        | 0.809       | 0.046       |
| Max              | 24.860        | 0.390        | 30.712      | 2.107       |
| Min              | −17.640       | 0.000        | 0.011       | 0.003       |
| Std. Dev.        | 2.740         | 0.045        | 1.680       | 0.174       |

### Panel D: Correlations of all variables

|                  | $MkNews_t$ | $FmNews_{it}$ | $SumMkNews_t$ | $SumFmNews_{it}$ | $dSpread_t$ | $Return_{it}$ | $InfoFlow_{it}$ | $Efficiency_{it}$ | $Imbal_{it}$ | $\Delta VIX_t$ | $Capit_{it}$ | $Illiq_{it}$ | $Volat_{it}$ |
|------------------|------------|---------------|---------------|-----------------|-------------|---------------|-----------------|-------------------|-------------|----------------|-------------|--------------|--------------|
| $MkNews_t$       | 0.034      | 0.827         | 0.040         | 0.059           | 0.387       | 0.027         | 0.019           | 0.236             | −0.064      | 0.012         | 0.026       | 0.037        |
| $FmNews_{it}$    | 0.038      | 0.845         | 0.049         | 0.059           | 0.410       | 0.032         | 0.022           | 0.285             | −0.055      | 0.008         | 0.052       | 0.085        |
| $SumMkNews_t$    | 0.050      | 0.066         | 0.399         | 0.031           | 0.023       | 0.259         | −0.059          | 0.010             | 0.030       | 0.041         | 0.030       | 0.041        |
| $SumFmNews_{it}$ | 0.055      | 0.422         | 0.036         | 0.626           | 0.301       | −0.048        | 0.009           | 0.058             | 0.092       | 0.023         | 0.033       | 0.092        |
| $dSpread_t$      | −0.360     | 0.160         | 0.127         | −0.158          | 0.102       | 0.018         | 0.012           | −0.125            | 0.154       | 0.163         | 0.154       | 0.163        |
| $Return_{it}$    | 0.057      | 0.043         | 0.144         | −0.173          | 0.024       | −0.044        | −0.069          |                  |             |               |             |              |
| $InfoFlow_{it}$  | 0.468      | 0.025         | 0.056         | −0.097          | 0.113       | 0.217         |                 |                  |             |               |             |              |
| $Efficiency_{it}$| 0.018      | 0.012         | −0.125        | 0.154           | 0.163       | 0.217         |                 |                  |             |               |             |              |
| $Imbal_{it}$     | −0.036     | −0.033        | 0.039         | −0.022          |            |               |                 |                  |             |               |             |              |
| $\Delta VIX_t$   | −0.008     | 0.083         | 0.131         |                 |             |               |                 |                  |             |               |             |              |
| $Capit_{it}$     | −0.263     | −0.205        | 0.326         |                 |             |               |                 |                  |             |               |             |              |
| $Illiq_{it}$     |              |               |               |                 |             |               |                 |                  |             |               |             |              |
| $Volat_{it}$     |              |               |               |                 |             |               |                 |                  |             |               |             |              |
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Efficiency = \(- \frac{\sigma_{\text{min}}}{5 \times \sigma_{\text{liquid}}^2} - 1\).

Panel B of Table 1 provides the summary statistics of all these dependent variables.

2.3. Control variables

We examine stock price reactions to macro and micro information in the context of exogenous shocks in investor attention. There is rich literature demonstrating the important role of investor sentiment in affecting stock market returns (e.g., Barberis et al., 1998; Da et al., 2014), which encourages us to consider market sentiment as a control variable in our return analysis. The Market Volatility Index (VIX) is widely perceived as a useful proxy for market sentiment (e.g., Whaley, 2000; Baker and Wurgler, 2007), and we include the change in the VIX in our regressions.

Our analyses of information flow and price efficiency also consider other factors that may exert their impacts. They include the realized volatility of 1-min returns Volat, Amihud’s (2002) illiquidity ratio Illiq, and market capitalization in trillions Capita. These variables are standard controls in studying price efficiency. For instance, Chordia et al. (2008) and Xu and Yin (2017) demonstrate that there is a significant relationship between liquidity and efficiency; Comerton-Forde and Putnins (2015) and Ben-David et al. (2018) consider volatility and capitalization in their efficiency regressions. The intraday prices for estimating Volat are obtained from the TRTH. The CRSP provides the data for daily returns, prices, volume, and the number of outstanding shares, which are used to calculate Illiq and Capita. We report the descriptive statistics of these control variables in Panel C of Table 1 and the correlations of all variables in Panel D.

3. The pandemic and biased stock market responses to news

3.1. Current stock returns

The onset of the COVID-19 pandemic may have induced some public panic, which could have a distracting effect on investor attention given some investors’ limited capacity to process information. Theoretically, limited investor attention can lead to category-learning behavior (i.e., investors processing more market information than firm-specific information) (Peng and Xiong, 2006). We conjecture that the pandemic makes some investors pay more attention to market-wide news and allocate relatively less attention to firm-level news, resulting in a stronger (weaker) stock market response to market-wide (firm-specific) news. We term this conjecture the limited attention hypothesis. To further capture the exogenous shock to investor attention due to the pandemic, we allow the allocation of attention between micro and macro information to vary with the epidemic spread. More specifically, we expect investor attention on market-wide (firm-specific) news to increase (decrease) with the epidemic spread, and we refer to it as the extended limited attention hypothesis.

To test our conjectures, we use the following regression to examine the effect of the pandemic on stock return sensitivities to news:

\[
\text{Return}_{it} = \alpha + \beta_1 \text{MkNews}_{it} + \beta_2 \text{FmNews}_{it} + \beta_3 \text{Volat}, \beta_4 \text{dSpread}, \beta_5 \text{Outbreak} + \beta_6 \text{VIX} + \sum_{k=1}^{5} \beta_7 \text{Return}_{i,t-k} 
\]

where MkNews, (FmNews,) is a daily measure of market-wide (firm-specific) news. X_t has two specifications: a dummy indicator of the pandemic outbreak in the full sample period and the measure of epidemic spread in the post-outbreak period. In the first specification, we focus on the period from January 2019 to December 2020 and construct the outbreak indicator Outbreak, which equals zero from January 1, 2019 to February 28, 2020 and unity for the rest sample days. In the second specification, we focus on the sub-period of February 29 to December 31, 2020 (i.e., the post-outbreak period) and use dSpread, to capture the detrended daily spread of the COVID-19 virus. In the regression, we control for the change in the market volatility index (ΔVIX), the five lagged stock returns (Return_{i,t-k}, k = 1, 2, ..., 5), and the five lagged market returns (MarketReturn_{i,t-k}, k = 1, 2, ..., 5). The regression also includes the stock fixed effects (FE_t) to account for unobserved stock characteristics and considers standard errors clustered at the stock level. In the limited attention hypothesis, we posit a stronger (weaker) stock return sensitivity to market-wide (firm-specific) news during the pandemic, and it is supported if we observe a significantly positive (negative) estimate of β_3 (β_2) in regression (1) for X_t = Outbreak.

In the extended limited attention hypothesis, we posit that stock return sensitivity to market-wide (firm-specific) news increases (decreases) with the epidemic spread, i.e., a significant and positive (negative) estimate of β_6 (β_7) in regression (1) for X_t = dSpread. To easily interpret the economic significance of each variable, we use the standardized variants of all regression variables.

The results are reported in Panel A of Table 2. Columns (1) and (2) display the output for the full-period estimation where X_t = Outbreak. The coefficients of MkNews and FmNews are significantly positive in both columns, consistent with a well-known

8 According to the data provided by the CDC, the U.S. has experienced an explosive spread of COVID-19 since February 29, 2020. The alternative outbreak dates in the U.S. could be one or two days earlier or later than this date according to different data sources. Applying these alternative outbreak dates to our analysis leads to qualitatively consistent findings.
Table 2
The pandemic and stock return responses to news.
This table presents the regression results of current and future stock returns for the impact of the pandemic on stock return responses to news. In Panel A, the dependent variable in the regression is the stock close-to-close returns of day \( t \), \( \text{Return}_t \). In Panel B, the dependent variable in the regression is the future stock returns over the next ten days, \( \text{Return}_{t+1,t+10} \). \( \text{MkNews}_t \) and \( \text{FmNews}_{it} \) indicate market-wide and firm-specific news on day \( t \), respectively. In both panels, columns (1) and (2) present the results for the full period from January 2019 to December 2020, and \( \text{Outbreak}_t \) is a dummy variable being zero during January 1, 2019 through February 28, 2020 and unity from February 29, 2020 onwards. Columns (3) and (4) present the results for the post-outbreak period from February 29 to December 31, 2020, and \( \Delta \text{VIX}_t \) is the detrended spread of the COVID-19 infection on day \( t \). \( \Delta \text{VIX}_t \) refers to the change in market volatility index. Stock fixed effects are included in all regressions, together with \( \Delta \text{VIX}_t \) and five lags of stock returns. Five lags of market returns are also included in the regressions for the even columns. Standard errors are clustered at the stock level. The \( t \)-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Current returns

|                  | Full period: \( \text{X}_t = \text{Outbreak}_t \) | Post-outbreak period: \( \text{X}_t = \Delta \text{VIX}_t \) |
|------------------|--------------------------------------------------|-------------------------------------------------------------|
|                  | (1)                                              | (2)                                                         |
| \( \text{MkNews}_t \) | 0.126*** (4.50)                                  | 0.106*** (3.79)                                             |
| \( \text{FmNews}_{it} \) | 0.134*** (4.80)                                  | 0.097*** (3.47)                                             |
| \( \text{X}_t \) | \(-0.115*** (-4.14) \)                          | \(-0.102*** (-3.66) \)                                     |
| \( \text{MkNews}_t \times \text{X}_t \) | 0.137*** (4.90)                                  | 0.108*** (3.86)                                             |
| \( \text{FmNews}_{it} \times \text{X}_t \) | \(-0.101*** (-3.63) \)                          | \(-0.095*** (-3.42) \)                                     |
| Constant & \( \Delta \text{VIX}_t \) | YES                                              | YES                                                         |
| Five lags of stock returns | YES                                              | YES                                                         |
| Five lags of market returns | YES                                              | YES                                                         |
| Stock fixed effects | YES                                              | YES                                                         |
| Adjusted R-squared | 0.06                                              | 0.06                                                        |

Panel B: Future returns

|                  | Full period: \( \text{X}_t = \Delta \text{VIX}_t \) | Post-outbreak period: \( \text{X}_t = \Delta \text{VIX}_t \) |
|------------------|--------------------------------------------------|-------------------------------------------------------------|
|                  | (1)                                              | (2)                                                         |
| \( \text{MkNews}_t \) | \(-0.039 (-1.40) \)                             | \(-0.061** (-2.19) \)                                       |
| \( \text{FmNews}_{it} \) | 0.047* (1.69)                                   | 0.064*** (2.30)                                             |
| \( \text{X}_t \) | \(-0.083*** (-3.00) \)                          | \(-0.066** (-2.38) \)                                       |
| \( \text{MkNews}_t \times \text{X}_t \) | \(-0.072*** (-2.60) \)                          | \(-0.063** (-2.27) \)                                       |
| \( \text{FmNews}_{it} \times \text{X}_t \) | 0.069** (2.48)                                  | 0.061** (2.17)                                             |
| Constant & \( \Delta \text{VIX}_t \) | YES                                              | YES                                                         |
| Five lags of stock returns | YES                                              | YES                                                         |
| Five lags of market returns | YES                                              | YES                                                         |
| Stock fixed effects | YES                                              | YES                                                         |
| Adjusted R-squared | 0.02                                              | 0.02                                                        |

relationship between returns and news. For instance, the coefficients of \( \text{MkNews}_t \) and \( \text{FmNews}_{it} \), are 0.117 and 0.122, respectively, in column (2), indicating that stock returns increase by 11.7% and 12.2% of their standard deviation when \( \text{MkNews}_t \) and \( \text{FmNews}_{it} \), increase by one standard deviation, respectively. Moreover, we observe a significantly negative coefficient for outbreak indicator \( \text{Outbreak}_t \). This confirms a slump in the stock market after the outbreak. For example, the coefficient of \( \text{X}_t \) is \(-0.108 \) in column (2), suggesting a reduction of average stock returns by 10.8% of their standard deviation after the outbreak. Turning to the interaction terms \( \text{MkNews}_t \times \text{X}_t \) and \( \text{FmNews}_{it} \times \text{X}_t \), we find that their effects are significant but asymmetric in both columns. On the one hand, the stock market becomes more sensitive to market-wide news after the outbreak, as evidenced by the positive coefficient of \( \text{MkNews}_t \times \text{X}_t \) being significant at the 1% level. On the other hand, the outbreak profoundly dulls the stock market reaction to firm-specific news, in the sense that the coefficient of \( \text{FmNews}_{it} \times \text{X}_t \) is negative and highly significant. This observation supports our inference that investors respond more promptly to market-wide news at the cost of less attention to firm-specific news after the pandemic outbreak, as we posit in our limited attention hypothesis.

Columns (3) and (4) display the output for the post-outbreak-period where \( \text{X}_t = \Delta \text{VIX}_t \) capturing daily shock to investor attention induced by the epidemic spread. We find that both market-wide and firm-specific news positively affect stock returns, as evidenced by their coefficients being positive and significant in both columns. More importantly, the magnitude and significance of the return effect of market-wide news are greater than those of firm-specific news, but it is the opposite case in the first two columns concerning the full period. This implies that macro news attracts increasing attention during the pandemic, whereas the effect of micro news on stock returns gets attenuated, which is consistent with investors’ attention constraints. Next, we confirm a significant and negative impact of the epidemic spread on the stock market in the post-outbreak period, as evidenced by the coefficient of \( \text{X}_t \) (i.e., \( \Delta \text{VIX}_t \)) being significantly negative in columns (3) and (4). This indicates that the stock market experiences more negative returns as the propagation of the virus turns speedier. Finally, the coefficient of \( \text{MkNews}_t \times \text{X}_t \) (\( \text{FmNews}_{it} \times \text{X}_t \)) is significantly positive (negative) in columns (3) and (4), indicating that stock return sensitivity to market-wide (firm-specific) news increases (decreases) with the epidemic spread, which is consistent with our extended limited attention hypothesis and higher (lower) attention allocated by investors to macro (micro) information.
3.2. Future stock returns

Above, we examine the contemporaneous responses of stock returns to news and document a strengthened (weakened) reaction to market-wide (firm-specific) news during the pandemic. If such biased reactions reflect investors’ overreaction (underreaction) to market-wide (firm-specific) news due to their heightened (reduced) attention to macro (micro) information, we expect to observe mispricing correction (delayed reaction) in future returns associated with the interaction term of $X_t$ and market-wide (firm-specific) news variables. To test this conjecture, we replace the dependent variable of the current day’s return $\text{Return}_{t,i}$ in regression (1) with the return over the next ten days, $\text{Return}_{t,i+1:10}$, and report the results in Panel B of Table 2.

Across all specifications in Panel B, the coefficient of $\text{MkNews}_i \times X_t$ is significantly negative. This indicates a negative effect of market-wide news in predicting $\text{Return}_{t,i+1:10}$ during the pandemic, which gets stronger when the epidemic spread is higher. The positive and significant coefficient of $\text{MkNews}_i \times X_t$ reported in the regressions of $\text{Return}_{t,i}$ in Panel A reveals that investors overreact to market-wide news during the pandemic, which increases with the epidemic scale and is followed by mispricing correction over the next few days. This suggests that investors pay excessive attention to macro information in the post-outbreak period, leading to an overreaction to market-wide news. This result is consistent with the model of Peng and Xiong (2006), where increased attention from overconfident investors can generate stock market overreaction. On the other hand, we find that $\text{FmNews}_{i,t} \times X_t$ has a significantly positive effect in predicting $\text{Return}_{t,i+1:10}$. This shows a delayed reaction to firm-specific news during the pandemic, and such delay is stronger when the epidemic spread is higher. Our results provide support for reduced investor attention to micro information when investors are distracted by the pandemic.

3.3. Pandemic epicenters

To capture the domestic spread of the COVID-19 in the U.S., we obtain state-level historical data from the COVID Tracking Project (https://covidtracking.com/). Following Bretscher et al. (2020), we identify the pandemic epicenters as the state-level epidemic spread scaled by the population size above the daily median across all states.\footnote{In robustness tests, we sort states into terciles, quartiles or quintiles based on the state-level epidemic spread scaled by the population size for each trading day and consider states in the top tercile, quartile or quintile as the pandemic epicenters. Our findings remain qualitatively similar.}

We obtain the firm headquarters locations from Compustat to take into account their geographical heterogeneity. We define $EC_{i,t}$ as a dummy variable that equals 1 if firm $i$ is headquartered in a state identified as a pandemic epicenter on day $t$ and 0 otherwise. To test the heterogeneity of the impact of the pandemic, we interact all regressors in regression (1) with the pandemic epicenter dummy $EC_{i,t}$ and add these interaction terms together with $EC_{i,t}$ into the regression. The results for the regressions of current stock returns are reported in Panel A of Table 3. In columns (1) and (2), the coefficient of $\text{MkNews}_{i,t} \times X_t \times EC_{i,t}$ remains significantly positive (negative), while the coefficient of $\text{MkNews}_{i,t} \times X_t \times EC_{i,t}$ is positive (negative) and significant at the 1% level. The results show increased (reduced) stock return sensitivity to market-wide (firm-specific) news for all firms during the pandemic and are stronger for firms located in the pandemic epicenters. For instance, in column (1), the coefficient for $\text{MkNews}_{i,t} \times X_t \times EC_{i,t}$ is $0.124 + 0.098 = 0.222$ ($-0.093 - 0.078 = -0.171$) for firms located in the pandemic epicenters and 0.124 (−0.093) for other firms, indicating much more increased (reduced) investor attention to macro (micro) information for firms in the epicenters. In columns (3) and (4) for the post-outbreak period, we observe similar patterns where the effects of $\text{MkNews}_{i,t} \times X_t$ and $\text{MkNews}_{i,t} \times X_t \times EC_{i,t}$ ($\text{MkNews}_{i,t} \times X_t$ and $\text{MkNews}_{i,t} \times X_t \times EC_{i,t}$) are both significantly positive (negative). It shows a stronger impact of the epidemic spread to distort stock return responses to news for firms in the epicenters, consistent with the heterogeneous impact of the pandemic.

In Panel B of Table 3, we report the results for the regressions of the future ten-day stock returns. The coefficients of $\text{MkNews}_{i,t} \times X_t$ and $\text{MkNews}_{i,t} \times X_t \times EC_{i,t}$ ($\text{MkNews}_{i,t} \times X_t$ and $\text{MkNews}_{i,t} \times X_t \times EC_{i,t}$) are significantly negative (positive) across all specifications, indicating there is more mispricing correction (delayed reaction) associated with macro (micro) information, reflecting more biased market reactions, for firms in the epicenters. In both Panels A and B, the coefficients for $EC_{i,t}$ are significantly negative, although the significance level decline in Panel B. The results show that the pandemic outbreak and its spread induce more damage on the stock returns for firms located in the epicenters and such damage continues to affect future stock returns, which is in line with Bretscher et al. (2020), who document more negative returns for firms headquartered in more affected areas. To sum up, our evidence reveals heterogeneity in the stock return sensitivities to market-wide and firm-specific news during the COVID-19 pandemic. For firms located in the epicenters, the pandemic leads to much more enhanced investor attention to market-wide news, whereas their attention to firm-specific news is impaired to a greater extent. This outcome is consistent with investors’ attention constraints and points to COVID-induced changes in their attention allocation.

3.4. Additional return analysis

In this section, we conduct the additional return analyses in three ways: good versus bad news, positive versus negative epidemic spread, and large-size versus small-size stocks.

3.4.1. Good news vs. bad news

There is an interesting question: Could good and bad news, market-wide or firm-specific, perform asymmetrically in the above...
Table 3
The pandemic epicenters and stock return responses to news
This table presents the regression results of current and future stock returns for the heterogeneous impact of the pandemic on stock return responses to news. The pandemic epicenters are identified as the states that have the state-level epidemic spread scaled by population size above the daily median. $EC_i$ is a dummy variable that equals 1 if firm $i$ is headquartered in the states identified as pandemic epicenters of day $t$ and 0 otherwise. In Panel A, the dependent variable in the regression is the stock close-to-close returns of day $t$, $Return_{it}$. In Panel B, the dependent variable in the regression is the future stock returns over the next ten days, $Return_{i(10)}$. $MkNews$, and $FmNews$, indicate market-wide and firm-specific news on day $t$, respectively. In both panels, Columns 1 and 2 focus on the full period from January 2019 to December 2020, and $Outbreak$, is a dummy variable being zero during January 1, 2019 through February 28, 2020 and unity from February 29, 2020 onwards. Columns 3 and 4 consider the post-outbreak period from February 29 to December 31, 2020, and $dSpread$, is the detrended spread of the COVID-19 infection on day $t$. $ΔVIX_t$ refers to the change in market volatility index. Stock fixed effects are included in all regressions, including $ΔVIX_t$ and five lags of stock returns. Five lags of market returns are also included in even columns. Standard errors are clustered at the stock level. The $t$-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Current returns

|               | Full period: $X_t = Outbreak_t$ | Post-outbreak period: $X_t = dSpread_t$ |
|---------------|---------------------------------|----------------------------------------|
| $MkNews_t$    | 0.117*** (4.20)                 | 0.108*** (3.89)                        | 0.098*** (3.52)                 | 0.088*** (3.16)               |
| $FmNews_{it}$ | 0.122*** (4.39)                 | 0.113*** (4.06)                        | 0.087*** (3.12)                 | 0.077*** (2.77)               |
| $EC_{it}$     | $-0.082**$ (-2.96)              | $-0.075**$ (-2.80)                     | $-0.074**$ (-2.65)             | $-0.070**$ (-2.51)           |
| $X_t$         | $-0.090***$ (-3.23)             | $-0.067**$ (-3.00)                     | $-0.081**$ (-2.90)             | $-0.073**$ (-2.63)           |
| $MkNews_t \times X_t$ | 0.124** (4.45)                  | 0.116** (3.19)                         | 0.089** (2.94)                 | 0.074** (2.66)               |
| $FmNews_{it} \times X_t$ | $0.098**$ (3.52)                | $0.089**$ (3.19)                       | $0.091**$ (3.57)               | $0.093**$ (3.34)             |
| $FmNews_{it} \times X_t \times EC_{it}$ | $-0.093**$ (-3.34)              | $-0.088**$ (-3.15)                     | $-0.073**$ (-2.61)             | $-0.070**$ (-2.50)           |
| $MkNews_{it} \times X_t \times EC_{it}$ | $-0.078**$ (-2.81)              | $-0.073**$ (-2.63)                     | $-0.064**$ (-2.29)             | $-0.061**$ (-2.18)           |
| $MkNews_{it} \times EC_{it}$ & $FmNews_{it} \times EC_{it}$ | YES & YES                          | YES & YES                             | YES & YES                     | YES & YES                     |
| Constant & $ΔVIX_t$ | YES                           | YES                                    | YES                           | YES                           |
| Five lags of stock returns | YES                          | YES                                    | YES                           | YES                           |
| Five lags of market returns | YES                         | YES                                    | YES                           | YES                           |
| Stock fixed effects | YES                          | YES                                    | YES                           | YES                           |
| Adjusted R-squared | 0.06                           | 0.06                                   | 0.05                          | 0.05                          |

Panel B: Future returns

|               | Full period: $X_t = Outbreak_t$ | Post-outbreak period: $X_t = dSpread_t$ |
|---------------|---------------------------------|----------------------------------------|
| $MkNews_t$    | $-0.036$ (-1.29)                | $-0.031$ (-1.12)                       | $-0.057**$ (-2.03)             | $-0.054*$ (-1.93)              |
| $FmNews_{it}$ | 0.044 (1.60)                    | 0.040 (1.45)                           | 0.059** (2.13)                 | 0.056** (2.00)                 |
| $EC_{it}$     | $-0.055**$ (-1.99)              | $-0.051*$ (-1.85)                      | $-0.048* ($1.74)               | $-0.046* (-1.66)               |
| $X_t$         | $-0.062**$ (-2.24)              | $-0.057**$ (-2.07)                     | $-0.055**$ (-1.98)             | $-0.052* (-1.90)               |
| $MkNews_t \times X_t$ | $-0.064**$ (-2.33)              | $-0.060**$ (-2.18)                     | $-0.057**$ (-2.07)             | $-0.054** (-1.97)              |
| $MkNews_{it} \times X_t \times EC_{it}$ | $-0.055**$ (-2.00)              | $-0.053* (-1.92)                      | $-0.051* (-1.84)               | $-0.048* (-1.75)               |
| $FmNews_{it} \times X_t$ | 0.060* (2.15)                   | 0.056* (2.00)                          | 0.055* (1.96)                  | 0.052* (1.89)                 |
| $FmNews_{it} \times X_t \times EC_{it}$ | 0.052* (1.88)                   | 0.050* (1.79)                          | 0.049* (1.76)                  | 0.046* (1.67)                 |
| $MkNews_{it} \times EC_{it}$ & $FmNews_{it} \times EC_{it}$ | YES & YES                          | YES & YES                             | YES & YES                     | YES & YES                     |
| Constant & $ΔVIX_t$ | YES                           | YES                                    | YES                           | YES                           |
| Five lags of stock returns | YES                          | YES                                    | YES                           | YES                           |
| Five lags of market returns | YES                         | YES                                    | YES                           | YES                           |
| Stock fixed effects | YES                          | YES                                    | YES                           | YES                           |
| Adjusted R-squared | 0.03                           | 0.03                                   | 0.03                          | 0.03                          |

observations? To answer it, we investigate the effects of the pandemic (in terms of its outbreak $Outbreak_t$ and spread $dSpread_t$) by considering good and bad news separately and extending regression (1) to:

$$Return_{it} = α + β_1 GdMkNews_t + β_2 BdMkNews_t + β_3 GdFmNews_{it} + β_4 BdFmNews_{it} + β_{5i} Outbreak_t + \sum_{k=1}^{5} β_{1i,k} Return_{i,k-1} + \sum_{k=1}^{5} β_{1i,k} MarketReturn_{i,k} + FE_i + ε_{it} \tag{2}$$

where $Gd$ ($Bd$) in front of the news variables indicates the inclusion of positive (negative) news only, i.e., the values of $ESS$ greater (smaller) than 50, in the construction of the variables. The other regression variables and settings remain unchanged from previously.

In columns (1) and (2) of Panel A in Table 4, we report the results of regression (2) and the Wald test results of the linear hypotheses about the coefficients for good news and bad news. We confirm that good (bad) news, market-wide or firm-specific, is related to the rise (drop) of stock returns. We also find that good market-wide news has a larger impact on returns than bad market-wide news. The difference in the coefficients of $GdMkNews_t$ and $BdMkNews_t$ is 0.040 (0.038) in column (1) (column 2) and significant at the 1% level. By contrast, we find the opposite for firm-specific news in both columns, where the difference in the coefficients of $GdFmNews_{it}$ and $BdFmNews_{it}$ is significantly negative at the 1% significance level. This implies that investors are more (less) attentive to positive
### Table 4

Additional return analysis.

This table presents the additional regression results of current and future stock returns for the impact of the pandemic on stock return responses to news. $\text{Return}_t$ denotes the stock close-to-close returns of day $t$, while $\text{Return}_{(t+1:t+10)}$ is the future stock returns over the next ten days. $\text{McNews}$ and $\text{FmNews}$ denote market-wide and firm-specific news on day $t$, respectively. We consider the full period from January 2019 to December 2020, where $\text{Outbreak}$, is a dummy variable being unity from February 29, 2020 onwards and zero otherwise, and the post-outbreak period from February 29 to December 31, 2020, where $\Delta \text{Spread}$, is the detrended spread of the COVID-19 infection on day $t$. In Panel A, good news and bad news are considered separately. $\Delta (\text{Bd})$ in front of the news variables indicates the only inclusion of positive (negative) news in their construction. In Panel B, we consider “out-of-control” and “under-control” situations separately for the post-outbreak period, and $\Delta \text{Spread}$, is split into $\Delta \text{Spread};$ and $\Delta \text{Spread};$ according to whether $\Delta \text{Spread}$, is positive or negative. In Panel C, large and small stocks are differentiated, and $\Delta \text{Spread}$ is a dummy variable that equals 1 for stocks with average daily market capitalization above the sample median and 0 otherwise. Panels A and B also present the Wald test results of the linear hypotheses about the coefficients. For all panels, $\Delta \text{VIX}$, refers to the change in market volatility index. Stock fixed effects are included in all regressions, together with $\Delta \text{VIX}$, and five lags of stock returns. Five lags of market returns are included in all columns except for the odd columns in Panel B. Standard errors are clustered at the stock level. The $t$-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

#### Panel A: Good news vs. bad news

| Dependent variable: | $\text{Return}_{(t+1:t+10)}$ | $\text{Return}_{(t+1:t+10)}$ |
|---------------------|-----------------------------|-----------------------------|
|                     | Full period:                | Post-outbreak period:       |
|                     | $X_t = \text{Outbreak}_t$  | $X_t = \text{dSpread}_t$   |
|                     | (1)                         | (2)                         |
| $\text{GdMcNews}_t$ | 0.121*** (4.32)             | 0.101*** (3.60)             |
| $\text{BdMcNews}_t$ | 0.081*** (2.89)             | 0.063*** (2.25)             |
| $\text{GdFmNews}_t$ | 0.092*** (3.28)             | 0.068*** (2.43)             |
| $\text{BdFmNews}_t$ | 0.126*** (4.51)             | 0.097*** (3.47)             |
| $\Delta\text{Return}$ | $\Delta\text{McNews}_t$ | $\Delta\text{FmNews}_t$ |
| $\Delta\text{Return}$ | $\Delta\text{McNews}_t$ | $\Delta\text{FmNews}_t$ |
| $\Delta\text{Return}$ | $\Delta\text{McNews}_t$ | $\Delta\text{FmNews}_t$ |

#### Hypothesis tests on the difference in coefficients:

| Coefficients | $t$-Statistics | $t$-Statistics | $t$-Statistics | $t$-Statistics |
|--------------|----------------|----------------|----------------|----------------|
| $\text{McNews}_t$ | 0.004*** (5.65) | 0.038*** (5.43) | $-0.011*$ (1.70) | $-0.013*$ (1.92) |
| $\text{FmNews}_t$ | 0.078*** (10.96) | 0.069*** (9.67) | $-0.023***$ (3.36) | $-0.023***$ (3.30) |
| $\text{(1)}\text{[5]}$ | 0.118*** (16.62) | 0.107*** (15.01) | $-0.034***$ (4.95) | $-0.036***$ (5.18) |
| $\text{(3)}$ | $-0.034**$ (4.90) | $-0.029**$ (4.20) | $-0.018**$ (2.62) | $-0.016**$ (2.35) |
| $\text{(7)}$ | $-0.129**$ (4.63) | $-0.113**$ (4.06) | $-0.080**$ (2.85) | $-0.071**$ (2.53) |
| $\text{(10)}$ | $-0.069**$ (2.48) | $-0.056**$ (1.98) | $-0.056**$ (2.01) | $0.046*$ (1.66) |

#### Panel B: Under-control situation vs. out-of-control situation for the post-outbreak period

| Dependent variable: | $\text{Return}_{(t+1:t+10)}$ | $\text{Return}_{(t+1:t+10)}$ |
|---------------------|-----------------------------|-----------------------------|
|                     | Full period:                | Post-outbreak period:       |
|                     | $X_t = \text{Outbreak}_t$  | $X_t = \text{dSpread}_t$   |
|                     | (1)                         | (2)                         |
| $\text{McNews}_t$ | 0.101*** (3.63)             | 0.091*** (3.25)             |
| $\text{FmNews}_t$ | 0.092*** (3.30)             | 0.082*** (2.95)             |
| $\Delta\text{Return}$ | $\Delta\text{McNews}_t$ | $\Delta\text{FmNews}_t$ |
| $\Delta\text{Return}$ | $\Delta\text{McNews}_t$ | $\Delta\text{FmNews}_t$ |
| $\Delta\text{Return}$ | $\Delta\text{McNews}_t$ | $\Delta\text{FmNews}_t$ |

#### Hypothesis tests on the difference in coefficients:

| Coefficients | $t$-Statistics | $t$-Statistics | $t$-Statistics | $t$-Statistics |
|--------------|----------------|----------------|----------------|----------------|
| $\text{McNews}_t$ | $-0.030***$ (4.39) | $-0.027***$ (4.04) | $-0.017**$ (2.56) | $-0.015**$ (2.20) |
| $\text{FmNews}_t$ | $0.037***$ (5.30) | $0.033***$ (4.80) | $-0.020**$ (3.01) | $-0.018**$ (2.69) |

#### Panel C: Large stocks vs. small stocks

| Dependent variable: | $\text{Return}_{(t+1:t+10)}$ | $\text{Return}_{(t+1:t+10)}$ |
|---------------------|-----------------------------|-----------------------------|
|                     | Full period:                | Post-outbreak period:       |
|                     | $X_t = \text{Outbreak}_t$  | $X_t = \text{dSpread}_t$   |
|                     | (1)                         | (2)                         |
| $\text{McNews}_t$ | 0.121*** (4.32)             | 0.101*** (3.60)             |
| $\text{FmNews}_t$ | 0.081*** (2.89)             | 0.063*** (2.25)             |
| $\Delta\text{Return}$ | $\Delta\text{McNews}_t$ | $\Delta\text{FmNews}_t$ |
| $\Delta\text{Return}$ | $\Delta\text{McNews}_t$ | $\Delta\text{FmNews}_t$ |
| $\Delta\text{Return}$ | $\Delta\text{McNews}_t$ | $\Delta\text{FmNews}_t$ |

#### Hypothesis tests on the difference in coefficients:

| Coefficients | $t$-Statistics | $t$-Statistics | $t$-Statistics | $t$-Statistics |
|--------------|----------------|----------------|----------------|----------------|
| $\text{McNews}_t$ | $-0.024**$ (3.64) | $-0.022**$ (3.29) | $0.018***$ (2.72) | $0.015**$ (2.25) |

(continued on next page)
market-wide (firm-specific) news than to negative market-wide (firm-specific) news. The psychology literature documents that negative information tends to outweigh positive information in individuals’ minds and such observation is known as the negativity bias and has been detected among market participants (e.g., Akhtar et al., 2011). Our results show that the negativity bias exists in the stock return sensitivity to micro information but does not hold for macro information.

In columns (1) and (2), the coefficients of $GdMkNews_i \times X_t$ and $BdMkNews_{iti} \times X_t$ ($GdFmNews_{iti} \times X_t$ and $BdFmNews_{iti} \times X_t$) are all significantly positive (negative). The results show that stock return response to market-wide (firm-specific) news is stronger (weaker) in the post-outbreak period and increases (decreases) with the epidemic spread for both positive and negative news, consistently supporting our limited attention argument. In column (1), the coefficient for $GdMkNews_{iti} + GdMkNews_{iti} \times X_t$ ($BdMkNews_{iti} + BdMkNews_{iti} \times X_t$) is $0.121 + 0.163 = 0.284$ ($0.081 + 0.085 = 0.166$), capturing the stock return sensitivity to good (bad) market-wide news during the pandemic, and the difference between the effects of good and bad market-wide news is 0.118 and significant at the 1% level, indicating more response to good market-wide news. In contrast, the difference between the coefficients for good and bad firm-specific news during the pandemic is $-0.094$ and significant at the 1% level, suggesting lower stock return sensitivity to good market-wide news. In addition, good market-wide news can be more discernible or more “attention-grabbing” during the pandemic, as evidenced by the coefficient of $GdMkNews_{iti} \times X_t$ having the largest magnitude and significance among the four interaction terms.

In columns (3) and (4) of Panel A in Table 4, we report the coefficients for regression (2) with the dependent variable being the future ten-day stock returns. The coefficients for good and bad market-wide (firm-specific) news are negative (positive) during the pandemic, and their magnitudes increase with the epidemic spread. The results indicate that there is mispricing correction (delayed correction) associated with both positive and negative market-wide (firm-specific) news during the pandemic, consistent with investors having attention constraints and allocating more (less) attention to macro (micro) information. In addition, the difference between the coefficients for good and bad market-wide (firm-specific) news is significantly negative (positive) in both columns, which is in line with the more biased responses to good news documented in columns (1) and (2).

### 3.4.2. Positive spread vs. negative spread

In our analysis for the post-outbreak period, we measure the epidemic strength using the detrended spread of COVID-19 infection $dSpread_t$, which captures the increase in new cases from the seven-day moving average. Thus, the positive (negative) values of $dSpread_t$ could imply the “out-of-control” (“under-control”) situation. To explore the asymmetric effects, we split $dSpread_t$ into $dSpread_t^+$ and $dSpread_t^-$ according to whether $dSpread_t$ is positive or negative on a day. We then extend regression (1) in the post-outbreak period by using $dSpread_t^+$ and $dSpread_t^-$ instead of $dSpread_t$, and report the estimation results for the regressions of current (future) stock returns in columns (1) and (2) (columns (3) and (4)) of Panel B in Table 4.

In all columns, the estimated coefficients for $dSpread_t^+$ and $dSpread_t^-$ and their difference is significantly negative, suggesting a stronger effect of $dSpread_t^+$ in reducing the current and future stock returns. Although both “out-of-control” or less “under-control”
situations of the pandemic jeopardize the stock market returns, we find a more harmful effect in the “out-of-control” situation. In columns (1) and (2), the coefficients for the interaction terms of $d\text{Spread}_t$ and $d\text{Spread}_t$ with market-wide (firm-specific) news and their difference are significantly positive (negative). The results confirm limited investor attention and biased reactions to macro and micro information during the pandemic. They also show a more substantial role of $d\text{Spread}_t$ (i.e., the “out-of-control” situation) in affecting investors’ attention allocation, which suggests that investors have a negativity bias and follow negative COVID-related information more closely. In columns (3) and (4), we find that mispricing correction (delayed reaction) associated with market-wide

Table 5
Robustness checks.
This table presents the results of the robustness checks for the impact of the pandemic on stock return responses to news. $Return_{it}$ denotes the stock close-to-close returns of day $t$; while $Return_{(i,t+1,10)}$ is the future stock returns over the next ten days. $Mk\text{News}_t$ and $Fm\text{News}_t$ indicate market-wide and firm-specific news on day $t$, respectively. We consider the full period from January 2019 to December 2020, where $Outbreak_t$ is a dummy variable being unity from February 29, 2020 onwards and zero otherwise, and the post-outbreak period from February 29 to December 31, 2020, where $d\text{Spread}_t$ is the detrended spread of the COVID-19 infection on day $t$. In Panel A, $Sum\text{Mk}\text{News}_t$ ($Sum\text{Fm}\text{News}_t$) denotes the alternative daily measure of market-wide (firm-specific) news calculated by summing all non-neutral news events. In Panel B, the full period is from July 1, 2018 in columns (1) and (2) and from January 1, 2018 in columns (3) and (4), respectively. In Panel C, the full (post-outbreak) period is from July 1, 2018 (February 29, 2020) to March 31, 2021. For all panels, $\Delta VIX$ refers to the change in market volatility index, and stock fixed effects are included in all regressions, together with $\Delta VIX_t$ and five lags of both stock and market returns. Standard errors are clustered at the stock level. The t-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

Panel A: Alternative measure of news variables

| Dependent variable: $Return_{it}$ | $Return_{(i,t+1,10)}$ |
|-----------------------------------|----------------------|
| **Full period:**                  | **Post-outbreak period:** |
| $X_t = Outbreak_t$                | $X_t = d\text{Spread}_t$ |
| $Sum\text{Mk}\text{News}_t$      | 0.128*** (4.59)       |
| $Sum\text{Fm}\text{News}_t$      | 0.136*** (4.86)       |
| $Outbreak_t$                      | -0.102*** (-3.68)    |
| $Sum\text{Mk}\text{News}_t \times Outbreak_t$ | 0.139*** (5.00) |
| $Sum\text{Fm}\text{News}_t \times Outbreak_t$ | -0.108*** (-3.89) |
| Constant & $\Delta VIX_t$         | YES                  |
| Five lags of stock returns        | YES                  |
| Five lags of market returns       | YES                  |
| Stock fixed effects               | YES                  |
| Adjusted R-squared                | 0.06                 |
|                                  | 0.05                 |

Panel B: Full-sample analysis with extended pre-outbreak period

| Dependent variable: $Return_{it}$ | $Return_{(i,t+1,10)}$ |
|-----------------------------------|----------------------|
| Starting from July 1, 2018        |                      |
| $Mk\text{News}_t$                | 0.110*** (3.94)       |
| $Fm\text{News}_t$                | 0.126*** (4.51)       |
| $Outbreak_t$                      | -0.102*** (-3.66)    |
| $Mk\text{News}_t \times Outbreak_t$ | 0.117*** (4.18) |
| $Fm\text{News}_t \times Outbreak_t$ | -0.100*** (-3.60) |
| Constant & $\Delta VIX_t$         | YES                  |
| Five lags of stock returns        | YES                  |
| Five lags of market returns       | YES                  |
| Stock fixed effects               | YES                  |
| Adjusted R-squared                | 0.06                 |
|                                  | 0.02                 |

Panel C: Additional analysis with extended pre- and post-outbreak periods

| Dependent variable: $Return_{it}$ | $Return_{(i,t+1,10)}$ |
|-----------------------------------|----------------------|
| Full period:                      |                      |
| $X_t = Outbreak_t$                | $X_t = d\text{Spread}_t$ |
| $Mk\text{News}_t$                | 0.112*** (3.99)       |
| $Fm\text{News}_t$                | 0.116*** (4.16)       |
| $Outbreak_t$                      | -0.095*** (-3.42)    |
| $Mk\text{News}_t \times Outbreak_t$ | 0.119*** (4.29) |
| $Fm\text{News}_t \times Outbreak_t$ | -0.088*** (-3.18) |
| Constant & $\Delta VIX_t$         | YES                  |
| Five lags of stock returns        | YES                  |
| Five lags of market returns       | YES                  |
| Stock fixed effects               | YES                  |
| Adjusted R-squared                | 0.06                 |
|                                  | 0.05                 |
(firm-specific) news increases with both $d\text{Spread}_t$ and $d\text{Spread}_t^{\ast}$ and the difference in the coefficients for the interaction terms is significantly negative (positive). The results confirm that the pandemic-induced changes in investor attention to macro and micro information are more evident in the “out-of-control” situation, supportive of the asymmetric effects between $d\text{Spread}_t$ and $d\text{Spread}_t^{\ast}$.

3.4.3. Large-size stocks vs. small-size stocks

Peng and Xiong (2006) show that limited attention leads to investors processing more market and sector-wide information than firm-specific information. When investors pay more attention to the market, they tend to concentrate on the larger and more visible firms (Drake et al., 2017). We thus expect to see more heightened attention to market-wide news in larger stocks, and consequently, the attention to firm-specific news is more impaired. To test this conjecture, we construct a dummy $\text{Large}$ to indicate whether a stock’s size is large or small according to the sample median of stock market capitalization and then extend regression (1) to include this dummy and its interaction terms. The results are reported in Panel C of Table 4. In columns (1) and (2) for the regressions of current stock returns, the coefficients of $\text{MkNews}_{t} \times X_t \ (\text{FmNews}_{t,1} \times X_t)$ and $\text{MkNews}_{t} \times X_t \times \text{Large} \ (\text{FmNews}_{t,1} \times X_t \times \text{Large})$ are both significantly positive (negative). The results confirm biased reactions to market-wide and firm-specific news and reveal more biased reactions in larger stocks, supporting our conjecture of more heightened attention to macro information for larger stocks. In columns (3) and (4) for the regressions of future stock returns, the coefficients of $\text{MkNews}_{t} \times X_t \ (\text{FmNews}_{t,1} \times X_t)$ and $\text{MkNews}_{t} \times X_t \times \text{Large} \ (\text{FmNews}_{t,1} \times X_t \times \text{Large})$ are both significantly negative (positive), indicating stronger mispricing correction (delayed reaction) is associated with market-wide (firm-specific) news for larger stocks, consistent with investor attention to larger stocks being more affected by the pandemic.

3.5. Robustness checks

In this section, we discuss additional robustness checks. In our main analysis, we calculate the daily news variables by averaging all scores of a day, which runs the risk of undermining the joint effect of two or more news items. To address this problem, we calculate alternative news variables by summing all scores of a day to account for cumulative effects:

$$\text{SumMkNews}_{t} = \sum_{k=1}^{n_t} \text{MacroNews}_{k,t};$$

$$\text{SumFmNews}_{t,i} = \sum_{k=1}^{n_t} \text{MicroNews}_{k,i,t}.$$  

Panel A of Table 5 reports the regression results for the alternative measurement of news variables. The coefficient of $\text{SumMkNews}_{t} \times X_t \ (\text{SumFmNews}_{t,1} \times X_t)$ is significantly positive (negative) in columns (1) and (2) for the regressions of current stock returns and becomes significantly negative (positive) in columns (3) and (4) for the regressions of future stock returns, showing biased reactions to macro and micro information and consistently supporting our findings in Subsections 3.1 and 3.2. In addition, the coefficients are of similar magnitude as those in Table 2, showing robust economic significance. For instance, the coefficients of $\text{SumMkNews}_{t}$ and $\text{SumFmNews}_{t,1}$ are 0.128 and 0.136, respectively, in column (1), indicating that stock returns increase by 12.8% and 13.6% of their standard deviation when

$$\text{SumMkNews}_{t} \text{ and } \text{SumFmNews}_{t,1} \text{ increase by one standard deviation, respectively.}^{10}$$

Our sample period is from January 2019 to December 2020 in the main analysis. For robustness tests, we extend the pre-outbreak period by starting the sample period in July 2018 (January 2018) in columns (1) and (2) (columns (3) and (4)) in Panel B. In Panel C, both the pre- and post-outbreak periods are extended, with the sample period covering July 2018 to March 2021. As shown in both panels, stock return sensitivity to market-wide (firm-specific) news is higher (lower) during the pandemic and increases (decreases) with the epidemic spread, followed by mispricing correction (delayed reaction), which is consistent with investors having heightened (impaired) attention to macro (micro) information during the pandemic.

To further reinforce our empirical evidence, we also perform a bundle of unreported robustness tests, summarized as follows. First, the outbreak date of the pandemic in the U.S. is set as February 28, 2020 in our analysis. However, the exact date of the outbreak remains debatable. We, therefore, consider alternative dates for the outbreak in robustness tests. To eliminate the potential bias, we replicate our experiments numerous times by altering the outbreak date to every trading day from January through February 2020, and the post-outbreak period is adjusted accordingly. Second, we modify our measure of epidemic spread by considering suspected and/or recovered cases. Specifically, the alternative $\text{Spread}_t$ is defined as:

$$\text{Spread}_{t} = (\text{Positive}_t - \text{Recover}_t) - (\text{Positive}_{t-1} - \text{Recover}_{t-1}) \text{ or}$$

$$\text{Spread}_{t} = (\text{Positive}_t + \text{Suspect}_t) - (\text{Positive}_{t-1} + \text{Suspect}_{t-1}) \text{ or}$$

$$\text{Spread}_{t} = (\text{Positive}_t + \text{Suspect}_t - \text{Recover}_t) - (\text{Positive}_{t-1} + \text{Suspect}_{t-1} - \text{Recover}_{t-1}).$$

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10 The coefficients in Panel A of Table 5 are slightly higher than their counterparts in Table 2. This suggests that summing all news events generates better results than averaging in terms of economic significance.
where Positive Suspect, and Recover are the daily numbers of confirmed, suspected, and recovered cases, respectively. Furthermore, we also consider new death cases instead of new infection cases and then conduct the replication. Finally, instead of detrending spread by removing the seven-day moving average from the raw series, we apply alternative detrending approaches by subtracting the linear time-trend over the raw series or taking a first-order difference on the raw series. Turning to the dependent variables, in addition to the current close-to-close return used in the main analysis, we also consider the open-to-close returns. The estimations with all alternative outbreak dates, pandemic variables, and return measurements generate qualitatively similar results. Though the results of these tests are not reported in the paper, they are available from the authors upon request.

4. Further tests based on order imbalance, information flow, and price efficiency

4.1. Order imbalance

We next examine how investors’ trading behavior, particularly their order imbalance, responds to information. We replace the dependent variable of the current day’s stock return in regression (1) with the current day’s imbalanced trading and report the results in Panel A of Table 6. Across all columns, the coefficients of $\Delta MkNews_t \times X_i$ ($\Delta FmNews_{st} \times X_i$) are significantly positive (negative), indicating that investors respond more (less) to market-wide (firm-specific) news during the pandemic and their response to market-wide (firm-specific) news increases (reduces) with the epidemic spread. It is consistent with investors having attention constraints and that their attention to macro (micro) information is heightened (reduced) during the pandemic.

4.2. Information flow

The nature behind the biased market reactions is the information flow from the news to stock prices, which requires investor attention. We examine whether the pandemic accelerates the incorporation of macro information into prices at the cost of impeding information incorporation related to firm-specific news and whether such change increases with the epidemic spread. Specifically, we replicate regression (1) by using the current day’s information flow to the stock as the dependent variable. We then consider the news measures and $\Delta TVX_i$ in their absolute values, given that innovations in news and market sentiment can influence stock price informativeness regardless of their signs. Because information flows over time, it is important to control for its persistence, captured by its first lag. We report the results in Panel B of Table 6. In all columns, the coefficients of $|MkNews_t|$ and $|FmNews_{st}|$ are positive and highly significant, confirming the information roles of market-wide and firm-specific news. The coefficients of $X_i$ are positive and significant at least at the 5% level, which indicates that information flow is higher during the pandemic and its spread positively affects the information flow. Across all columns, the coefficients of the interaction term $|MkNews_t| \times X_i$ ($|FmNews_{st}| \times X_i$) are significantly positive (negative), suggesting that market-wide (firm-specific) news has an enhanced (weakened) effect on the information flow to the stock after the COVID-19 outbreak, which increases with the epidemic spread. It is in line with our findings in Section 3.1 and supports that the pandemic impacts investor attention, leading to more (less) attention paid to market-wide (firm-specific) news, which facilitates (deters) the incorporation of macro (micro) information.

4.3. Price efficiency

We provide evidence that the COVID-19 pandemic has considerable impacts on stock return sensitivities to market-wide and firm-specific news, imbalanced trading, and information flow. Next, we examine the stock market efficiency to verify these findings. We replicate our analysis for Panel B of Table 6 by using the current day’s stock price efficiency as the dependent variable instead and report the results in Panel C of Table 6. The results are clearly consistent with the analysis of information flow. We reveal the explicit effects of the two types of news and the pandemic in terms of its outbreak and spread on stock price efficiency. More importantly, the significant and biased impacts exerted by the pandemic on the efficiency effects of market-wide and firm-specific news are also evident. The efficiency improvement driven by market-wide (firm-specific) news gets stronger (weaker) during the pandemic and changes with the epidemic spread. The results again confirm our conjecture on investors’ attention constraints.

5. Conclusion

We examine how the COVID-19 pandemic in the U.S. influences stock market responses to market-wide and firm-specific news. We argue that investors have attention constraints, and the pandemic can induce them to pay excessive attention to macro information and distract them from micro information. Our results show that stock return sensitivity to market-wide (firm-specific) news is higher (lower) during the pandemic and increases (decreases) with the epidemic spread, and such overreaction (underreaction) to macro (micro) information is followed by mispricing correction (delayed reaction) in future returns. It is consistent with limited investor attention and points to changes in investor attention induced by the pandemic. Using geographical dispersion of firm headquarters, it is evident. The efficiency improvement driven by market-wide (firm-specific) news gets stronger (weaker) during the pandemic and changes with the epidemic spread. The results again confirm our conjecture on investors’ attention constraints.

The infection data including suspected cases is available from the website of the COVID Tracking Project.
Table 6
Further tests based on order imbalance, information flow, and price efficiency.

This table presents further test results for the impact of the pandemic on stock return responses to news. In Panel A, the dependent variable in the regression is the stock’s imbalanced trading of day \( t \), \( \text{Imbalance}_{it} \). Panel B considers the daily information flow to the stock, \( \text{InfoFlow}_{it} \), as the dependent variable of the regression, while Panel C considers the daily stock price efficiency, \( \text{Efficiency}_{it} \). \( \text{MkNews}_{it} \) and \( \text{FmNews}_{it} \) indicate market-wide and firm-specific news on day \( t \), respectively, which in the absolute values are indicated by \( |\text{MkNews}_{it}| \) and \( |\text{FmNews}_{it}| \). In all panels, columns (1) and (2) consider the full period from January 2019 to December 2020, where \( \text{Outbreak} \) is a dummy variable being unity from February 29, 2020 onwards and zero otherwise, and columns (3) and (4) consider the post-outbreak period from February 29 to December 31, 2020, where \( \text{dSpread} \) is the detrended spread of the COVID-19 infection on day \( t \). This table presents further test results for the impact of the pandemic on stock return responses to news. In Panel A, the dependent variable in the regressions, and standard errors are clustered at the stock level. The \( t \)-statistics are reported in parentheses. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively.

### Panel A: Imbalanced trading

|                  | Full period: \( X_t = \text{Outbreak}_t \) | Post-outbreak period: \( X_t = d\text{Spread}_t \) |
|------------------|-------------------------------------------|-----------------------------------------------|
|                  | (1)                                       | (2)                                           | (3)                                           | (4)                                           |
| \( \text{MkNews}_{it} \) | 0.098*** (3.52)                           | 0.090*** (3.24)                               | 0.092*** (3.30)                               | 0.085*** (3.03)                               |
| \( \text{FmNews}_{it} \) | 0.112*** (3.99)                           | 0.101*** (3.62)                               | 0.077*** (2.76)                               | 0.071** (2.56)                                |
| \( X_t \)         | \( 0.083*** (-2.97) \)                    | \( -0.072** (-2.61) \)                        | \( -0.068** (-2.45) \)                        | \( -0.061** (-2.19) \)                        |
| \( \text{MkNews}_{it} \times X_t \) | 0.114*** (4.06)                           | 0.108*** (3.86)                               | 0.089*** (3.18)                               | 0.083*** (2.97)                               |
| \( \text{FmNews}_{it} \times X_t \) | \( -0.081*** (-2.90) \)                  | \( -0.076** (-2.73) \)                        | \( -0.070** (-2.51) \)                        | \( -0.064** (-2.30) \)                        |
| Constant & \( |\Delta VIX| \)      | YES                                       | YES                                           | YES                                           | YES                                           |
| Five lags of stock returns | YES                                       | YES                                           | YES                                           | YES                                           |
| Five lags of market returns | YES                                       | YES                                           | YES                                           | YES                                           |
| Five lags of imbalance | YES                                       | YES                                           | YES                                           | YES                                           |
| Stock fixed effects | YES                                       | YES                                           | YES                                           | YES                                           |
| Adjusted R-squared | 0.05                                       | 0.05                                          | 0.04                                          | 0.04                                          |

### Panel B: Information flow

|                  | Full period: \( X_t = \text{Outbreak}_t \) | Post-outbreak period: \( X_t = d\text{Spread}_t \) |
|------------------|-------------------------------------------|-----------------------------------------------|
|                  | (1)                                       | (2)                                           | (3)                                           | (4)                                           |
| \( |\text{MkNews}_{it}| \) | 0.199*** (7.09)                           | 0.167*** (5.94)                               | 0.175*** (6.25)                               | 0.144*** (5.14)                               |
| \( |\text{FmNews}_{it}| \) | 0.220*** (7.83)                           | 0.182*** (6.49)                               | 0.146*** (5.20)                               | 0.118*** (4.20)                               |
| \( X_t \)         | \( 0.101*** (3.60) \)                    | \( 0.084*** (2.98) \)                        | \( 0.081*** (2.90) \)                        | \( 0.067** (2.39) \)                        |
| \( |\text{MkNews}_{it}| \times X_t \) | \( 0.202*** (7.19) \)                    | \( 0.173*** (6.16) \)                        | \( 0.169*** (6.03) \)                        | \( 0.142*** (5.06) \)                        |
| \( |\text{FmNews}_{it}| \times X_t \) | \( -0.153*** (-5.50) \)                   | \( -0.130*** (-4.68) \)                      | \( -0.130*** (-4.65) \)                      | \( -0.110*** (-3.95) \)                      |
| Constant & \( |\Delta VIX| \)      | YES                                       | YES                                           | YES                                           | YES                                           |
| Lagged dependent variable | YES                                       | YES                                           | YES                                           | YES                                           |
| Other controls | YES                                       | YES                                           | YES                                           | YES                                           |
| Stock fixed effects | YES                                       | YES                                           | YES                                           | YES                                           |
| Adjusted R-squared | 0.16                                       | 0.20                                          | 0.12                                          | 0.15                                          |

### Panel C: Price efficiency

|                  | Full period: \( X_t = \text{Outbreak}_t \) | Post-outbreak period: \( X_t = d\text{Spread}_t \) |
|------------------|-------------------------------------------|-----------------------------------------------|
|                  | (1)                                       | (2)                                           | (3)                                           | (4)                                           |
| \( |\text{MkNews}_{it}| \) | 0.171*** (6.08)                           | 0.141*** (5.01)                               | 0.147*** (5.24)                               | 0.123*** (4.40)                               |
| \( |\text{FmNews}_{it}| \) | 0.188*** (6.70)                           | 0.157*** (5.59)                               | 0.128*** (4.55)                               | 0.098*** (3.50)                               |
| \( X_t \)         | \( 0.082*** (2.94) \)                    | \( 0.073*** (2.58) \)                        | \( 0.066** (2.38) \)                        | \( 0.057** (2.02) \)                        |
| \( |\text{MkNews}_{it}| \times X_t \) | \( 0.172*** (6.11) \)                    | \( 0.139*** (4.97) \)                        | \( 0.151*** (5.37) \)                        | \( 0.120*** (4.28) \)                        |
| \( |\text{FmNews}_{it}| \times X_t \) | \( -0.136*** (-4.88) \)                   | \( -0.110*** (-3.96) \)                      | \( -0.108*** (-3.90) \)                      | \( -0.088*** (-3.15) \)                      |
| Constant & \( |\Delta VIX| \)      | YES                                       | YES                                           | YES                                           | YES                                           |
| Lagged dependent variable | YES                                       | YES                                           | YES                                           | YES                                           |
| Other controls | YES                                       | YES                                           | YES                                           | YES                                           |
| Stock fixed effects | YES                                       | YES                                           | YES                                           | YES                                           |
| Adjusted R-squared | 0.012                                      | 0.014                                         | 0.09                                          | 0.10                                          |

negativity bias and their tendency to more closely follow negative information, making their attention to bad news less vulnerable to the pandemic. There exist more biased reactions to information for larger stocks and when the pandemic is out of control. Furthermore, we show that the heightened (reduced) attention to market-wide (firm-specific) news leads to higher (lower) order imbalance, information flow, and market efficiency associated with macro (micro) information.

At the time of writing, the economic disruption of the pandemic is ongoing and has become even worse in some areas. Our findings provide a timely and important contribution to understanding the influence of the pandemic on information incorporation. We reveal distorted investor attention to macro and micro information during the pandemic, and it offers a new perspective to understand the post-outbreak market dynamics.
