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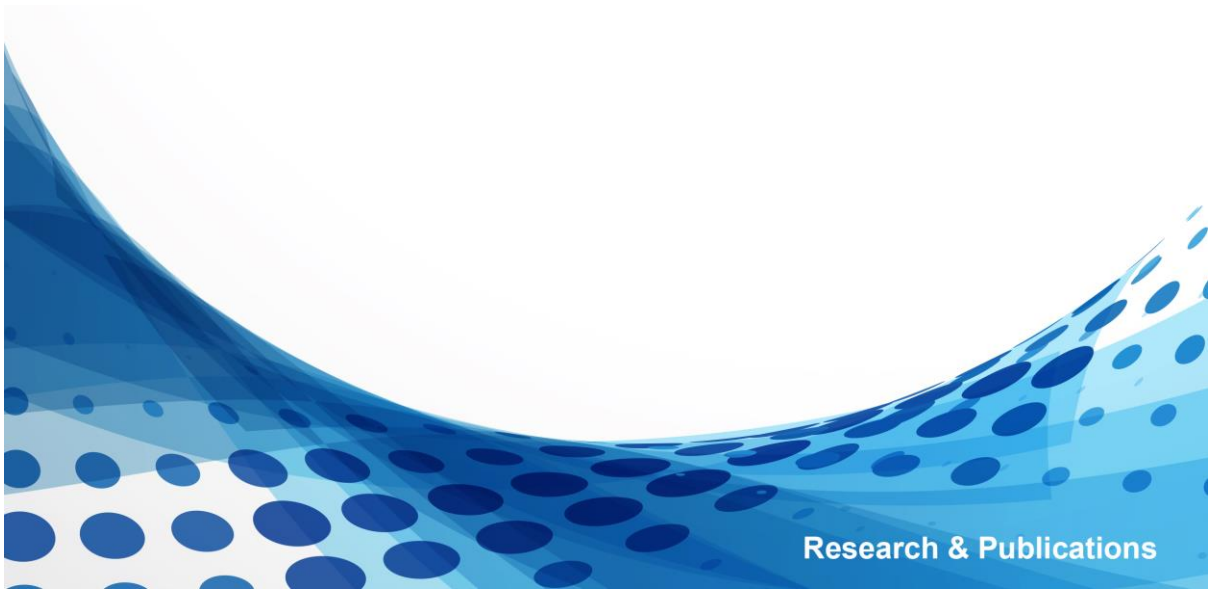

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Abstract

The paper investigates how the market infers changes in the firm-level discount rate (risk information) in normal and turbulent times. The study focuses on two key sources of risk information, earnings announcements of firms and changes in the market risk premium. We employ a recently proposed measure that limits the impact of event risk while estimating the forward-looking risk information from option prices. We find that both earnings announcements and the changes in market risk impact firm-level discount rates, but both sources exhibit a significant time variation. The impact of market risk changes is lower in favorable conditions and higher during crisis periods. Using COVID-19 as an exogenous shock, we show that the influence of earnings announcements becomes insignificant during a crisis. The results suggest lower attention to firm-specific risk factors in times of a systemic crisis, in contrast to normal times.

Key words: Risk information, earnings announcements, COVID-19, discount rate, asset pricing

JEL classifications: G12, G14, G40

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1 Introduction

The price of a financial asset is determined by its future stream of cashflows, discounted by a risk-adjusted rate. Therefore asset prices are impacted by a change in either the expected cashflows or the discount rate applied to the cashflows (Campbell and Shiller, 1988; Campbell and Vuolteenaho, 2004; Cohen et al., 2003; Penman and Yehuda, 2019). The discount rate applicable to the stock of a firm has two components. Under the Capital Asset Pricing Model (CAPM), one component is the covariance of a firm's cashflows with that of the market, known as the market beta. The other component is the risk premium that the investors demand for holding the market portfolio itself known as the market risk premium. Accordingly, the discount rate applicable to a stock is the product of the market beta and the market risk premium.

The discounting rate is expected to evolve with the "firm risk information" reflective of the arrival of risk-related news in the market. The risk information related to a firm can thus be (a) due to changes in beta, reflective of firm-specific risk information (hereafter, 'beta risk information') or (b) due to changes in market risk premium corresponding to changes in the market-wide risk (hereafter, 'market-wide risk information'). In this paper, we examine the likely time-variation in the influence of the two different sources of risk information by investigating their impact during normal and stressed market conditions.

The study assumes significance as the impact of risk on asset prices is known to be time-varying. For instance, research shows that there is greater (lower) attention to risk in bad (good) market conditions (Guiso et al., 2018; Cohn et al., 2015; Hoffmann et al., 2013). For instance, Guiso et al. (2018) show that investors' risk aversion has increased after the 2008 financial crisis due to greater salience of negative outcomes. Cohn et al. (2015) use an experiment to show that when primed with a bust finance professionals show an increased risk aversion. Hence, market conditions are likely to influence the extent to which risk information is incorporated into the discounting rate. Furthermore, research finds that a systemic crisis leads to higher co-movement of stock returns (Boyer et al., 2006; Chiang

and Zheng, 2010). This is argued to be due to irrational inattention to firm-specific news (Peng and Xiong, 2006; Hirshleifer et al., 2009). Alternatively, it also argued on account of rational inattention linked to the lower cost of processing market-wide news (Veldkamp, 2006; Hameed et al., 2015). Prior research also shows that attention-grabbing events lead to herding and increased attention to a few stocks, resulting in a higher return comovement (Barber and Odean, 2008; Da et al., 2011), especially during crisis periods (Boyer et al., 2006; Chiang and Zheng, 2010). Therefore it can be expected that there will be a greater influence of market-wide risk information than beta risk information, during a crisis.

We use the COVID-19 pandemic as an exogenous event to examine how the impact of the two sources of risk information is different during normal periods and a crisis period. The COVID-19 crisis has been acknowledged as a market-wide shock due to the uncertainty surrounding its impact on firms (Ding et al., 2021; Ramelli and Wagner, 2020). In India, the response to the spread of the virus was immediate and announcements such as restrictions on interstate travel and closure of facilities in affected areas, harmed most businesses, irrespective of their industries (Bansal et al., 2022). It is likely that during the COVID-19 period, there is greater investor attention to market-wide news instead of firm-specific news. Therefore, we believe that a study on the impact of beta risk information and market-wide risk information during the pre-COVID-19 period and the COVID-19 period would deepen the understanding of the linkage between risk information and market conditions.

We estimate both the sources of risk information using an option-derived measure, that is argued to capture innovations in equity risk more reliably than the existing measures, recently proposed by Smith and So (2022). The measure captures changes in forward-looking equity risk without the influence of the uncertainty of a scheduled information event, which creeps into commonly used alternative measures, such as the change in the implied volatility (Patell and Wolfson, 1979, 1981; Hann et al., 2019).

We focus on own and peer firms' earnings announcements as the sources of firm-specific beta risk information. A firm's own earnings announcements are known to be key sources

of firm-level information (Kothari, 2001; Ball and Brown, 1968) and so are those of peer firms (Foster, 1981; Brochet et al., 2018). Peer firms' earnings announcements are shown to inform the market about likely changes in the firm-level credit risk (Hertzel and Officer, 2012). However, it is yet to be examined whether they carry equity risk information, reflective of the innovations in beta. The market-wide risk information is elicited from the index option prices.

The paper specifically examines the following aspects of the role of risk information in the pricing of stocks. First, we examine the degree to which own earnings announcements and peer firms' earnings announcements carry beta risk information for non-announcing firms across the two states of the market. Second, we investigate the extent to which the market-wide risk information is correlated with the innovations in the discounting rate of a firm. Third, as risk-aversion is known to be countercyclical, we examine, how the correlation between market-wide risk information and discount rate innovations changes across periods with varying market returns. Finally, we examine how the association between the market-wide risk information or beta risk information and firm risk information varies during a crisis episode such as the COVID-19 crisis.

We use the high-frequency option prices of the single stock options and index options traded on the National Stock Exchange (NSE) of India to estimate risk information. The firm risk information is extracted from single stock options and the market-wide risk information is extracted from the NIFTY options. The sample period spans from January 2016 to September 2021. We consider the period from January 2016 to December 2019 as our normal period sample. The rest of the sample is employed in the analysis of the impact of the COVID-19 pandemic.

The option-derived measure of risk information serves two purposes. Primarily, as option-derived measures are forward-looking, they more effectively capture the likely change in the forward-looking risk of the underlying stock. Furthermore, as argued in Smith and So (2022), this measure extracts the risk information free from the influence of the event risk itself.

Limiting the influence of the event risk is important, as volatility can be induced by an anticipated information event on account of possible informed trading etc., which is reflected in the option implied volatility (see Barth and So, 2014; Patell and Wolfson, 1979). Our key findings and their implications are as follows.

First, we find that on the day of a firm's earnings announcement, the firm risk information is approximately twenty times that of an average day during the Pre-COVID-19 period. We also find that on days of a peer firm's earnings announcement, the firm risk information of a non-announcing firm is approximately six times that of an average trading day. These findings imply that along with a firm's own earnings announcements, which carry risk-relevant information for the firm a peer firm's announcement also informs the market of the change in its beta risk.

Second, we find that the market-wide risk information and firm risk information, are positively correlated. Moreover, the positive correlation is greater for firms with higher ex-ante market risk (firms with a higher CAPM beta). This suggests that the discount rate news of the firm is correlated with that of the market and the positive relationship is amplified by a firm's market risk. The evidence indicates that part of the change in the discount rate risk of a firm is due to innovations in the market risk premium, consistent with the argument of Campbell and Vuolteenaho (2004) and Cochrane (2011). The finding also shows that the option-derived measure proposed by Smith and So (2022) for capturing risk innovations of a firm produces predictable cross-sectional variation in the correlation of firm risk information with the market-wide risk information. A riskier firm is likely to be greater exposed to the innovations in the market risk, in line with the findings of Campbell and Vuolteenaho (2004) and we show that that is indeed the case.

Third, we find that during periods of high market returns, the positive correlation between a firm risk information and market-wide risk information is smaller. Particularly, a 1% increase in market returns in a quarter reduces the coefficient of correlation by about 5%. The finding is consistent with a lower (higher) risk aversion in good (bad) market conditions as

shown by Guiso et al. (2018), who find that risk aversion is lower in good market conditions. We examine further whether a higher risk aversion in bad market conditions or a lower risk aversion in good market conditions drives our results, by examining it separately for periods that fall into the top and bottom quartile by returns. We find that it is the lower influence of market-wide risk information in periods with high returns (top quartile) that drives our findings. Particularly in periods that fall into the top two quartiles of market returns, the correlation between the market-wide and the firm risk information is significantly smaller, while there is no indication of a higher correlation in low market return quartiles. Hence, the results imply that investors have lower risk-aversion in good market conditions.

Finally, we use the COVID-19 crisis as an exogenous shock to examine how the magnitude of the risk information contained in earnings announcements and the influence of the market-wide risk information change during periods of crisis. We find that the risk information of a firm's own earnings announcement and the spillover of beta risk information from a peer firm's announcement becomes insignificant during the COVID-19 period. It indicates that firm-specific risk information has a diminished role in times of systemic shock, such as a pandemic. Furthermore, we find that the correlation between the firm risk information and the market-wide risk information is not impacted during the crisis period, relative to normal times. Our finding indicates a greater information relevance of market-wide risk information in times of crisis compared to firm announcements.

The paper contributes significantly to several strands of literature. First, by showing that peer firm's announcements carry risk-relevant information for non-announcing firms we extend the existing literature on the spillover of information during firm announcements (Foster, 1981; Brochet et al., 2018; Hann et al., 2019). Second, by showing that the market-wide risk information and firm risk information are positively correlated and that the correlation is higher for firms with higher ex-ante market risk, we contribute to the literature on discount rate news impacting asset prices (Campbell and Vuolteenaho, 2004; Cochrane, 2011; Penman and Yehuda, 2019).

Third, we show that the attention to the firm-specific risk and market-wide risk is time-varying. In this regard, we contribute to the literature on time-varying risk aversion (Guiso et al., 2018; Cohn et al., 2015), by documenting that during times of good market-wide conditions, the association between the firm risk information and market-wide risk information is relatively smaller. Furthermore, by employing the COVID-19 crisis as an exogenous shock that increased the uncertainty in financial markets, we show that in periods of heightened uncertainty, firm announcements have a diminished ability to impact firm risk information. Additionally, the association between firm risk information and market-wide risk information is not impacted by the increased uncertainty. We, therefore contribute to the literature on rational and irrational inattention on firm-specific news, in times of a distracting event (Hirshleifer et al., 2009; Veldkamp, 2006; Peng and Xiong, 2006).

The remainder of the paper is as follows. Section 2 lays down the conceptual background and describes our hypotheses. Section 3 details the methodology and data. Section 4 discusses the key findings and the associated insights. The last section concludes with the implications of our findings on firm level risk information.

2 Conceptual background and hypotheses

The discount rate applicable to a firm is impacted by two different sources, under a single factor model like CAPM. It is impacted by the covariance of a firm's cashflows with those of the market, known as the market Beta of a firm's stock. It is also impacted by the risk premium that investors demand for holding the market portfolio itself, referred to as the risk premium. Hence, the expected return on an asset, at time t under the CAPM is:

$$r_{it} = r_f + \beta_{it} \times (r_m - r_f)_t \tag{1}$$

Therefore, the changes in the discount rate (risk information) of a firm over time can be due to changes in $\beta_{i,t}$, which is firm-specific risk information (beta risk information), or due to changes in $(r_m - r_f)_t$, which are changes in the risk premium for holding the market

portfolio (market-wide risk information).

Events such as earnings announcements of a firm help to resolve the uncertainty that the market associates with a firm (Verrecchia, 1983; Rogers et al., 2009; Patell and Wolfson, 1979). In line with this argument, Verrecchia (1983) shows that a firm is better off by disclosing the information that it holds and thereby mitigating the uncertainty. Rogers et al. (2009) find that while earning forecasts increase uncertainty the subsequent earnings announcements decrease it. Patell and Wolfson (1979) show that in response to earnings announcements, the implied volatility of a firm decreases. The evidence from earnings announcements suggests that such events reveal significant firm-level risk information to the market, as found by Smith and So (2022).

However, markets are also likely to learn about firm-level risk information from the scheduled announcements of peer firms. In this regard, Foster (1981) show that investors learn from peer firms' earnings announcements as reflected in the stock price reaction of the non-announcing firms. Brochet et al. (2018) show that the earnings calls of peer firms carry substantial price-sensitive information for non-announcing firms. Hann et al. (2019) show that the change in implied volatility of the non-announcing firms is correlated with the announcing firms of the same industry on the announcement day, indicating a spillover of forward-looking uncertainty. Given the evidence on the role of the earnings announcement of peer firms, we hypothesize the following:

Hypothesis 1: *Fundamental risk information spills over to industry peers during the scheduled earnings announcements of a firm.*

Earnings announcements, as argued earlier, are likely to inform the market about the innovations in firm-level risk, reflective of the systematic risk in its cashflows (beta risk information). The other component of firm risk information is the changes in market risk premium.

As discussed elsewhere, the risk information has a component that is correlated with the news about the market-wide risk. Hence we hypothesise:

Hypothesis 2a: *Firm risk information should be positively correlated with market-wide risk information.*

With the recently proposed method of Smith and So (2022), it is possible to estimate the market-wide risk information and the firm risk information directly from traded option prices. Therefore it is possible to test directly if changes in market-wide risk impact that of the firm.

Moreover, as a firm with higher ex-ante market risk (higher beta) is expected to be more sensitive to market-wide discount rate news, as the CAPM suggests, we also hypothesise:

Hypothesis 2b: *The positive correlation between the market-wide risk information and firm risk information should be higher for firms with a higher beta.*

Risk aversion is known to be countercyclical in nature as it increases in times of a crisis and decreases in good times (Guiso et al., 2018; Cohn et al., 2015). Guiso et al. (2018) use survey data from Italian investors to show that risk aversion increased during the 2008 financial crisis. Cohn et al. (2015) find that when finance professionals were primed with bust scenarios, they were more fearful in their decision-making, indicating a greater risk aversion.Hoffmann et al. (2013) document that the risk tolerance of individual investors decreased and at the same time their risk perceptions increased during the worst months of the 2008 Global Financial Crisis, leading to an overall increase in risk premium. Consistent with the documented increase in risk aversion during times of crisis, we hypothesise:

Hypothesis 2c: *The positive correlation between the market-wide risk information and firm risk information should be lower (higher) during periods of high (low) market returns.*

Furthermore, during crisis periods, it is known that systemic factors assumed a greater role in the pricing of stocks. The COVID-19 pandemic forced countries worldwide to respond with immediate steps to check the spread of the virus and extend fiscal and monetary support to businesses (see Ding et al., 2021; Ramelli and Wagner, 2020; Alfaro et al., 2020). For

instance, industry-level characteristics such as the suitability of a firm for remote working played a significant role (Hassan et al., 2020; Gopalakrishnan et al., 2022). Ramelli and Wagner (2020) show that in the initial months of the crisis, all firms that were exposed to trade with China showed a particularly stark decline in their stock prices. Alfaro et al. (2020) show that industries that were more prone to the transmission of the virus, for instance, hospitality, reacted more negatively. Bansal et al. (2022) show that firms that had plants located in areas that were severely impacted by the crisis, had large negative stock price reactions.

Such characteristics of the COVID-19 period are likely to have made asset prices more sensitive to macro-level news compared to firm-level news. Corroborating the lower significance of firm-level information, Dong et al. (2021) show that investors sought less firm-level information during the COVID-19 crisis. With google search volume they show that retail investors searched less for firm-specific information around earnings announcements.

Hence, it is likely that during the COVID-19 period, macro factors and market-level announcements assume a greater significance for a firm's risk information, compared to firm-specific beta risk information. Prior research suggests that in times of investor inattention, investors underreact to firm-specific news and incorporate market-level news into prices more readily (Peng and Xiong, 2006; Hirshleifer et al., 2009; Cohen and Frazzini, 2008). Peng and Xiong (2006) show that when attention becomes a binding constraint, investors exhibit category learning behaviour, leading to greater focus on market and industry level information instead of firm-specific information. Hirshleifer et al. (2009) show that on days when a large number of firms in an industry announce their earnings, the price impact of a firm's earning surprise is weak. Furthermore, research argues that when elements of information are relevant for pricing a larger number of assets, they are more likely to be acquired as it results in a lower cost of information production (for instance, Veldkamp, 2006). Hence, we hypothesise the following:

Hypothesis 2d: *Both firm's own earnings announcements and peer firm earnings announce-*

ments have lower significance in determining the risk information of a firm during the COVID-19 period.

3 Methodology and data

3.1 Methodology

To examine the impact of a scheduled event, such as an earnings announcement, on the risk of the cashflows of a firm, prior research has relied on either the change in option implied volatility (ΔIV) around the scheduled event (see, Hann et al., 2019) or the change in the dispersion of analyst forecasts around the event (Pandit et al., 2011). However, it has been shown that the pre-event dispersion in analyst forecasts has no predictive ability for the future realised volatility of a firm (for instance, Dubinsky et al., 2019). Hence, as a measure of future risk information, it is found to be unreliable. On the other hand, research shows that implied volatility has predictive power for the future realised volatility (Christensen and Prabhala, 1998). Therefore, its change around an event like an earnings announcement is correlated with the stock-specific risk information revealed by the event. However, as a proxy of risk information of an event, ΔIV is a noisy measure (Smith and So, 2022; Dubinsky et al., 2019). The reason is that option implied volatility immediately before a scheduled event consists of two components. First, the market expectation of the risk of the cashflows (fundamental risk) revealed through an event, the focal point of our study.[1] Second, the market expectation of the variance of the price response on the event day (called event risk). Therefore, it is contaminated by the event risk. On the contrary, the implied volatility (IV) measured from option prices after an event consists of only the market's expectation of the cashflow risk of the firm. Therefore, we control for the event risk, as detailed below.

Accordingly, to measure the risk information revealed by a scheduled event, we first need to measure the total change in the forward-looking risk of a firm that is likely revealed by

[1]Part of the fundamental risk of the cashflows is reflected in the discount rate of the firm.

the event. This is done by measuring the ΔIV from traded options around the event. ΔIV is estimated from the most at-the-money (ATM) option immediately prior to the event, as implemented by Dubinsky et al. (2019) Hann et al. (2019). Accordingly,

$$\Delta IV = (IV_{T+1,t1} - IV_{T-k,t1}) \tag{2}$$

where $IV_{T+1,t1}$ denotes the IV measured 1-day after the event day T, for an option that matures $t1$ days from the announcement. Similarly,$IV_{T-k,t1}$ denotes the IV of the same option k days prior to the event day T. We use $k = 1$ in our baseline estimates and $k = 2$ in the robustness checks.

As discussed earlier, ΔIV around an event contains the event risk. To isolate the change in the fundamental risk of the firm, we need to calculate the event risk reflected in the market prices before the event. Dubinsky et al. (2019) and Smith and So (2022) propose that the term structure of option prices trading just before an event can be used to calculate the event risk. Particularly, we use the following approach to estimate the event risk:

$$Event\ risk = \frac{(IV_{T-k,t1} - IV_{T-k,t2})}{\left(\frac{1}{t1} - \frac{1}{t2}\right)} \tag{3}$$

Essentially, we calculate the difference between the IVs of two options, maturing at different time points after the event, both measured immediately before the event. The intuition is that immediately before the event, the IV of the shorter maturity option will contain the event risk to a greater degree, compared to that of the longer maturity option. Alternatively, the IV of the longer maturity option reflects a greater degree of the fundamental risk of the underlying equity.

Accordingly, following Smith and So (2022), we calculate the fundamental risk informa-

tion associated with an event, (called $Riskinfo_{i,t}$) for a firm i on day t as:

$$Riskinfo_{i,t} = t1 \times \frac{\underbrace{[(IV_{T+1,t1} - IV_{T-k,t1})]}_{\text{Change in implied volatility}} + \underbrace{[IV_{T-k,t1} - IV_{T-k,t2}]}_{\text{Event risk}}}{\left(\frac{1}{t1} - \frac{1}{t2}\right)} \tag{4}$$

Based on the above expression, risk information can be computed for each day, for each firm that has traded options. In the estimation of the time series of risk information, we assume that there is an event anticipated by the market, which can influence the IV of the traded options. The event risk is estimated using Equation 3. If there is no anticipated event on a particular day, then the term structure of the IV will not capture an event risk. Hence the change in IV, as given by Equation 2 will capture the risk information of the event, without the contamination of the event risk.

Analogously, market-wide risk information can also be estimated, from the index option prices. The daily time series of market risk information will reflect a significant correction to ΔIV, whenever there are significant events in the market such as monetary policy announcements, budget announcements, etc. We denote the risk information estimated from the index as *Index riskinfo*$_t$. It represents the change in the market risk or the market-wide risk information on the day t.

Within the time series of beta risk information, we specifically identify event days associated with scheduled earnings announcements. Based on such identification, we test the Hypothesis 1 on risk information spillover with the following specification:

$$\begin{aligned} RiskInfo_{ik,t} = \beta_0 + \beta_1 \times Own\ period_t + \beta_2 \times Peer\ firm\ announcement_t \\ + \Sigma_{n=1}^{N} \gamma_k \times X_{ik,t} + \delta_i + \theta_{k,q} + \epsilon_{i,t} \end{aligned} \tag{5}$$

where, $RiskInfo_{i,k,t}$ is the firm risk information of firm i which belongs to an industry k on day t, $Own\ period_t$ is an indicator variable that takes the value 1 if t is within a 5-day window of firm i's own earnings announcement day, and 0 otherwise. $Peer\ firm\ announcement_t$ is

a dummy variable that takes the value 1 if it is the announcement day of a large peer firm j, and 0 otherwise. We define a large peer firm of firm i as the following. It is a firm in the top quintile of market capitalization distribution of the firms within the same industry as firm i.[2] $X_{i,k,t}$ are N control variables. We control for the maturity of the early expiry option among the pair used to estimate firm risk information as the IV is impacted by the time remaining to maturity (see for instance, Gatheral, 2011). *Index riskinfo*$_t$, as discussed above, is also included among the control variables to control for market-wide risk information that is likely to impact the firm risk information.

δ_i captures the time-invariant firm fixed effects, that control for the inherent riskiness of certain firms, which makes their perceived risk more sensitive to news. For instance firms in relatively opaque industries such as banking are likely to be impacted to a greater degree by the peer banks' announcements. $\theta_{k,q}$ captures the industry-period fixed effects (industry year-quarter fixed effects for the quarter q). These are included to control for any time-varying, unobserved factors that may impact certain industries in certain quarters, making their cashflow risk particularly different. For instance, during the COVID-19 period, it is likely that firms in the hospitality industry were particularly sensitive to the lockdown announcements.

Further, we examine if the announcements made by larger peers have a stronger spillover of firm risk information to non-announcing peers. For this purpose, we modify the specification as in Equation 5 to include additional dummy variables to represent days of small peer firms' earnings announcements (called, *Smaller peer announcement*). We expect the smaller peers' announcement days to impact a non-announcing firm's risk information to a lesser degree compared to a larger peer's earnings announcement.

Next, To test the Hypothesis 2b, which predicts the impact of firm characteristics on the

[2]In our estimation, if a peer firm announcement coincides with the *Own period*$_t$, we make the *Own period*$_t$ 1 and $Peer\ firm\ announcement_t$ 0, implying that all peer firm announcements that fall within the firm's own earnings announcement period are not considered as peer firm announcement days (Hann et al., 2019; Thomas and Zhang, 2008).

association between market-wide and firm risk information, we use the setup as below:

$$\begin{aligned} RiskInfo_{i,k,t} = \beta_0 + \beta_1 \times Own\ period_t + \beta_2 \times Peer\ firm\ announcement_t \\ + \Sigma_{n=1}^{N} \gamma_n \times X_{i,k,t} \times Index\ riskinfo_t + \delta_i + \theta_{k,q} + \epsilon_{i,t} \end{aligned} \tag{6}$$

The coefficients of interest in the above equation are the γ_n's, which capture how each of the firm characteristics impacts the correlation of firm risk information with the $Index\ riskinfo_t$. The key characteristic that we employ is the market risk of a firm (CAPM $Beta$). The CAPM $Beta$ is estimated as the sensitivity of its last 36 monthly returns to those of the market, where the market is proxied by the NIFTY index. We also use the book-to-market ratio of a firm (BM) and its size ($Mcap$) to examine if growth firms or smaller firms are more sensitive to market-wide risk information.

Furthermore, we examine if the level of market returns impacts the relationship between market-wide risk information and firm risk information, in line with Hypothesis 2c. We employ the setup below to examine this hypothesis:

$$\begin{aligned} RiskInfo_{i,k,t} = \beta_0 + \beta_1 \times Own\ period_t + \beta_2 \times Peer\ firm\ announcement_t \\ + \beta_3 \times Index\ riskinfo_t \times Market\ return_q \\ + \Sigma_{z=1}^{N} \eta_z \times Y_{i,k,t} + \delta_i + \theta_{k,q} + \epsilon_{i,t} \end{aligned} \tag{7}$$

where $Market\ return_q$ is the return of the market in quarter q. The coefficient of the interaction term of quarterly market returns $Market\ return_q$ and the market-wide risk information $Index\ riskinfo_t$ (β_3) is expected to be negative and significant, as a higher market return should lead to a lower correlation between the market-wide and the firm risk information. $Y_{k,i,t}$ are N controls that include the idiosyncratic volatility of firms in the past 36 months in addition to those employed in the previous specifications. This is because a larger $IVOL$ is likely to be associated with more volatile firms which are also likely to have a greater option implied volatility (Dennis et al., 2006).

In an alternative specification, instead of the continuous variable to represent quarterly market returns, we use dummy variables to represent the level of market returns. To do this, we assign each quarter into 4 quartiles by market returns and then employ the corresponding dummies in the specification given below.

$$\begin{aligned} RiskInfo_{i,k,t} = \beta_0 + \beta_1 \times Own\ period_t + \beta_2 \times Peer\ firm\ announcement_t \\ + \Sigma_{p=1}^{4} \zeta_p \times Index\ riskinfo_t \times Market\ return\ quartile_{p,q} + \Sigma_{z=1}^{N} \eta_z \times Y_{i,k,t} + \delta_i \\ + \theta_{k,q} + \epsilon_{i,t} \end{aligned} \tag{8}$$

where $Market\ return\ quartile_{p,q}$ indicates the quartile p to which return of the market of the quarter q belongs, among all quarters from January 2016 to December 2019. A higher value of p denotes a higher relative market return in the quarter q. We expect the coefficients ζ_p to be negative and significant for higher values of p, indicating a decline in the positive correlation between market-wide and firm risk information in times of higher market returns.

3.2 Data

We use the high-frequency single stock options (SSO) data and the high-frequency stock trading data provided by the NSE to calculate the option implied volatility (IV) for each firm for each day. Our universe consists of all the firms that have traded options on their stock. The period of the baseline analysis starts in January 2016 and ends in December 2019. We call this period a "normal period". We begin our investigation in January 2016 because the SSO market in India developed considerable volume only after 2015 (Agarwalla et al., 2021). Subsequently, we also include the pandemic period and a post-pandemic period in our sample. The pandemic period represents the months with the highest uncertainty during the onset of the crisis and spans from March 2020 to June 2020. We call this period the "Covid period". The post-pandemic period, which begins from July 2020 and extends till

September 2021, is named "Post pandemic period". We discuss the classification criteria in greater detail in Section 4.4.

The high-frequency data consists of tick-by-tick traded prices of options as well as the underlying stocks. The daily IV is estimated from the daily data by matching the last traded price of an option with that of the underlying stock, to the nearest minute.

We use several standard filters to select the sample of options. First, we exclude all options for a day that are traded less than five times on that day to eliminate infrequent options whose traded price may reflect spurious information (Chan et al., 1993). Second, we exclude options that have less than three days to expiry to eliminate any expiration day effects from our data. Finally, as we require at least two traded options on a day for a firm, with two different maturities, to estimate the event risk before an event (Equation 3), we eliminate all firm days where traded options with at least two maturities are unavailable. For each trading day, two options with the same underlying and two different maturities are selected. The first option expires in the last week of the same month. The second option expires in the last week of the next month. This turns out to be the bottleneck in terms of data availability as options maturing the next month are often thinly traded. From a possible 128,211 firm days for which it is possible to estimate the change in IV, our sample for the normal period is therefore reduced to 16,942 firm-days. This sample represents the options of 54 unique firms.

As mentioned, the first step is the calculation of implied volatility for each option. Using the options and the matched spot market price, we estimate the implied volatility for each option for that trading day. We then select the most ATM call option and the most ATM put option for that day and calculate the average IV of the two. This is the IV that we take for a firm-day-maturity. Then, we calculate the event risk with traded option prices, one day and two days before the event (see, Dubinsky et al., 2019; Smith and So, 2022) using Equation 3. To calculate the total change in forward-looking risk (Equation 2), we calculate the difference between the IVs of the day $T+1$ and day $T-1$, concerning the

day of observation. For this purpose, we use only the option series expiring in the same month as the observation (Dubinsky et al., 2019). Finally, for each firm-day, we calculate the $Riskinfo$ following Equation 4. As we measure the event risk on two separate days, we get two separate measures of $Riskinfo$, a one day (two day) $Riskinfo$ using the event risk one day (two days) before the observation day denoted by $Riskinfo$ ($Riskinfo$ (2 day)).

We also calculate the $Index\ riskinfo$ ($Index\ riskinfo$ (2 day)) for the market-wide risk information, using NIFTY options and NIFTY index following Equation 2, Equation 3 and Equation 4 and following the procedure outlined above for single stock options. As observed in the case of firm risk information, the average is close to 0 with a substantial variation across days, as captured by a relatively high standard deviation.

The summary statistics for the normal period are presented in Table 2, Panel A. In India, monthly options expire on the last Thursday of any month. The mean $Riskinfo$ ($Riskinfo$ (2 day)) for a firm-day is 0.00019 (0.00018) with a very high standard deviation. This is close to 0 on a non-event day as possibly no substantial information on fundamental risk is released on a non-event day. For an average (median) firm day, the nearest monthly expiry is approximately 12 (10) days away, which indicates a nearly uniform distribution of $Time\ to\ maturity$. The mean (median) $Beta$ or the market risk is approximately 1.22 (1.21), which indicates that in our sample the average firm has a slightly higher market risk than the market itself. This is expected as most firms in our sample are mature and large, which tend to have higher market risk. The market capitalization of the average (median) firm in our sample is approximately INR 730 (814) billion. For comparison, the average market capitalization of the top 50 firms by size in India is approximately INR 2500 billion, indicating that our sample comprises considerably large firms.

In our sample, approximately 9% of the days correspond to a firm's own announcement period and approximately 12% of the days correspond to a top quintile peer firm's announcement day. We must point out that we lose a substantial number of firm days as we do not have data to calculate the risk information for these firm days. Nevertheless, we get a sub-

stantial number of firm days without any significant own or a peer firm event. The summary statistics of the Covid period and the Post covid period are presented in Table 2, Panel B. As observed, the summary stats remain largely similar to those in the normal period.

4 Findings and discussion

4.1 Firm risk information and earnings announcements

In this section, we discuss the results of the hypotheses on the spillover of risk information from a peer firm's announcement (Hypothesis 1). The results of the estimation of Equation 5 are shown in Table 3. Indicating the significance of a firm's own earnings announcement, the coefficient of *Own period* is statistically significant in all columns from (1) to (4). The coefficient in column (3), for instance, implies that the average risk information (*Riskinfo*) in the 10-day window surrounding a firm's earnings announcement is about 0.23%, which is about 20 times the *Riskinfo* of an average firm-day (0.018%). Hence, earnings announcements facilitate risk updation in the market for the announcing firm and hence are extremely informative events. The significance of a firm's own earnings announcement confirms the findings of Smith and So (2022) that substantial firm risk information is released around the earnings announcements of firms.

More importantly, as hypothesised, we find that a large peer's announcement is also an informative event about the risk of a firm. The coefficient of $Peer\ firm\ announcement$ is about 0.07% and is statistically significant. This implies that on the earnings announcement days of large peers, the firm risk information released is about seven times that on an average firm-day and about a third of the magnitude of the firm risk information of the firm's own announcement period. This indicates that the market learns about the change in fundamental risk of the non-announcing firm from the peer firm's earnings announcements. Given that a firm can have more than one large peer announcement in a quarter, this points

to substantial learning about firm risk from peer announcements.[3]

We also examine if there is a substantial difference between the announcement of big and small peer firms. Our empirical design does not allow us to use a window of days for peer firms' announcements. We consider only a peer announcement day as the event day and not the days surrounding a peer firm's announcement. Therefore, *Peer firm announcement* takes the value 1, only on the day of a peer firm's announcement and not on days surrounding it. This is contrary to what we do for a firm's own announcement, where *Own period* is 10 days surrounding a firm's earnings announcement. We make this choice because earnings announcements are often made in clusters (Frederickson and Zolotoy, 2016; Hirshleifer et al., 2009). Due to the clustering of earnings announcements, identification of the source of risk information is difficult with overlapping announcement windows.

For the estimation, we classify the firms in the same industry as the target firm, into quintiles. We then employ two separate dummy variables, one for a large (top quintile) and one for a small peer firm's announcement day, both of which must be outside a firm's own announcement period. The results are presented in Table 4. As shown the coefficients for both *Peer firm announcement* and *Smaller peer anouncement* are positive and significant in columns (1) through (4). Although the coefficient for *Peer firm announcement* is larger in magnitude, the difference is not substantial. Therefore we find that a peer's announcement is informative to the market irrespective of the size of the announcing firm.

Among the control variables, *Index riskinfo* is extremely significant and positive, indicating that market-wide risk information is correlated with firm risk information. This is expected in line with Hypothesis 2a. We examine this relationship between the market and firm risk information in greater detail in the next Section 4.2.

Given the significance of earnings announcements for risk information, we examine if the market infers (*Riskinfo*) from earnings announcements differently for firms that vary

[3]In unreported results we compare the *Riskinfo* from early and late announcers. We find no significant difference between the impact of the two. We, therefore, attribute the average impact of *Peer firm announcement* to all the large peer firms.

in their information environment or the degree of information asymmetry. As a proxy for the degree of information asymmetry, we employ the idiosyncratic volatility ($Ivol$) of a firm. A larger ex-ante $Ivol$ indicates a greater information asymmetry associated with the stock price of a firm (see, for instance, Stambaugh et al., 2015). Therefore the market is likely to infer risk information to a greater degree from the earnings announcements of firms with a higher ex-ante $Ivol$. For estimation, we interact the dummies *Own period* and $Peer\ firm\ announcement$ with $Ivol$. $Ivol$ is estimated from the error terms of the market model, using monthly stock returns and the market returns as reflected by the NIFTY index (see Table 1 for variable definitions).

The results of the estimation are shown in Table 5. The coefficient of *Own period* $\times$ $Ivol$ is statistically significant in columns (1)-(4), indicating that the market learns *Riskinfo* to a greater degree for firms with a larger $Ivol$. We, however, do not find any impact of $Ivol$ on the informativeness of peer firms' earnings announcements.

Our findings suggest that in addition to a firm's own earnings announcement, those of large peer firms are informative of changes in the equity risk of a firm. The results imply that peer firms' earnings announcements are a source of the beta risk information. Our findings extend the research of Smith and So (2022), who show that a firm's own earnings announcements are a significant source of risk information to the market. Furthermore, the market learns risk information from the earnings announcements of firms with greater information asymmetry, to a greater degree, compared to firms that are less informationally opaque.

4.2 Firm risk information and market-wide risk information

The results so far have shown that peer firms' announcements are risk-relevant events for a firm and also that market-wide risk information is correlated with firm risk information. We deepen the analysis by examining if firm characteristics impact the correlation of the market-wide risk information with the firm risk information. We employ Equation 6 to

examine the likely cross-sectional differences in the correlation of firm risk information with market-wide risk information. Particularly, to test our Hypothesis Equation 2b, we interact the *Index riskinfo* with a firm's market *Beta*, which is a proxy for the exposure of a firm to the market.

The results of the estimation (Equation 6) are presented in Table 6. As shown, the coefficient of *Index riskinfo* $\times$ *Beta* is positive and significant. It implies that with an increase in ex-ante market risk there is a higher exposure of firm risk information to market-wide risk information. Particularly, a one-unit increase in a firm's *Beta* leads to a 35% increase in the sensitivity of firm risk information to the market-wide risk information. The result is intuitive as firms with high market risk are likely also exposed to innovations in the market risk premium to a higher degree. By showing a predictable variation in the exposure of the firm risk information to market-wide risk information with cross-sectional variation in *Beta*, the result corroborates that the measure of *Riskinfo* indeed captures a change in risk of the firm. Our approach, hence, suggests that firms with a higher systematic risk are riskier as they are exposed to a greater degree to the changes in the market-wide risk.

It is worth pointing out that the coefficients of the interaction of *Index riskinfo* with the other two priced characteristics, *BM* and *Mcap*, are not significant. This is expected as the associated priced risk factors are known to be uncorrelated with each other and the risk of the market is captured only by the *Beta* of a firm. Finally, given that our measure is an option-derived measure of change in risk, our results indicate a strong link between the risk measures derived from the cash and the derivative markets.

4.3 Association between firm risk information and market-wide risk information - Market phases

The results so far indicate that innovations in market-wide risk are positively correlated with the firm risk information. We also find that the firms with a higher market beta have greater exposure to market-wide risk information. Extending the above findings, we examine if the

relationship between the market-wide risk information and discount rate innovation varies with the market phases. We expect a higher (lower) market return to lead to a lower (higher) association of the market-wide risk information with the firm risk information, in line with our Hypothesis 2c. We interact the *Index riskinfo* with quarterly market returns to examine the impact on the exposure of firm risk information to market-wide risk information.

The results of the estimation based on Equation 7 are presented in Table 7 (in columns (1) and (2)). The coefficient of *Index riskinfo* $\times$ *Market return* is significant and negative. It indicates that in times of higher market returns, the impact of market-wide risk information on the firm risk information is significantly lower. A one percent increase in the market return lowers the association of market-wide risk information and firm risk information by approximately two units, corresponding to about a 5% reduction in the coefficient of *Index riskinfo*. The results are broadly consistent with an increased (decreased) risk aversion in bad (good) market conditions as argued by Guiso et al. (2018) and Cohn et al. (2015).

The observed decline in the exposure of the firm risk information to market-wide risk information during periods of high market returns could emerge from two complementary effects. Investors possibly incorporate market-wide risk information into firm risk information in bad times to a greater degree as compared to that in normal periods. Alternatively, it could emerge from a lower influence of market-wide risk information on firm risk information in periods characterized by high market returns. Either effect is consistent with risk aversion that varies with market phases. To examine which of the two effects, or both, drive our results, we interact the dummy variables to represent market phases (quartiles) with the market-wide risk information, as in Equation 8. The findings are given in columns (3) and (4) in Table 7. As shown, the coefficients of *Index riskinfo* $\times$ *Market return quartile* & *Index riskinfo* $\times$ *Market return quartile* are negative and significant, which indicates that in our sample it is the lower impact of market-wide risk information in good times that drives the results. Again, in these estimations coefficients of all the other variables retain their sign and significance, as in Section 4.1.

In addition, we control for the $Ivol$ or idiosyncratic volatility of a firm. It is expected that a firm with a higher $Ivol$ has higher risk information, as innovations in its risk could lead to greater volatility. In line with this argument, we find the coefficient of $Ivol$ positive and significant. Finally, we investigate whether the systematic risk of a firm impacts the relation between market-wide risk information and the firm risk information, as observed in different phases of the market. For the estimation, employ triple interactions involving $Index\ riskinfo$, $Market\ return$, and $Beta$. The results are reported in Table 8. The coefficient of $Index\ riskinfo\ \times Market\ return \times Beta$ is positive and significant in all the specifications. For instance, a firm with one unit higher $Beta$ has about 3.4 units greater impact of the market-wide risk information when the quarterly market return increases by 1% (as compared to a firm with one unit lower $Beta$ for the same 1% rise in quarterly market return).

Overall, we find that firm risk information is positively correlated with the market-wide risk information, indicating a significant impact of innovations in market-wide risk on the firm level discounting rate. The impact is greater for firms with a higher ex-ante market risk, consistent with the systematic risk of a firm driving its exposure to the market-wide risk. Consistent with a lower risk aversion, we find that during periods of high market returns, the impact of market-wide risk innovations into firm risk innovations is lower, especially for low beta firms. Prior research has documented that expected returns are low (high) in times of high (low) market returns, consistent with time-varying investor preferences (Barberis et al., 2001; Bordalo et al., 2012; Guiso et al., 2018). As variation in expected returns significantly explains asset prices (Cochrane, 2011; Campbell and Shiller, 1988), a lower influence of market-wide risk information in phases of high market returns support "denominator-effect" contributed by time-varying risk aversion. Our findings, therefore, provide further evidence on the mechanism that drives return predictability across time.

4.4 Risk information - COVID-19 pandemic period

In this section, we focus on the change in the nature of the risk information spillover around earnings announcements made during the uncertain period, represented by the COVID-19 crisis. We also investigate if there is any noticeable change in the impact of the market risk information on firm risk information during the crisis period. In our analysis thus far, we had considered data on risk information from January 2016 to December 2019, to avoid the influence of the pandemic period. To examine the impact of the COVID-19 crisis on the spillover of risk information between firms and from the market to a firm, we extend the sample to include the pandemic period. Particularly, our baseline estimation involving the pandemic period extends the sample until June 2020. The months from March 2020 to June 2020 are identified as the *Covid period* and the rest of the sample period is identified as *Pre-covid period*. Prior studies on the impact of the COVID-19 pandemic on the Indian market have employed the same period as the months with heightened uncertainty on account of the COVID-19 pandemic (see Bansal et al., 2022).[4]

The estimation of the change in the impact of the risk information from firm-level earnings announcements and the market is carried out using the difference-in-differences (DiD) approach as given below,

$$\begin{aligned} RiskInfo_{i,k,t} = {} & \beta_0 + \beta_1 \times Own\ period_t + \beta_2 \times Peer\ firm\ announcement_t \\ & + \beta_3 \times Index\ riskinfo_t + \beta_4 \times Own\ period_t \times Covid\ period_t \\ & + \beta_5 \times Peer\ firm\ announcement_t \times Covid\ period_t \\ & + \beta_6 \times Index\ riskinfo_t \times Covid\ period_t \\ & + \Sigma_{z=1}^{N} \eta_z \times Y_{i,k,t} + \delta_i + \theta_{k,q} + \epsilon_{i,t} \end{aligned} \tag{9}$$

[4]The India VIX, a measure of the uncertainty in the market, was particularly high from March 2020 to June 2020. It settled to a relatively lower level from July 2020 (Source: https://www.moneycontrol.com/indian-indices/india-vix-36.html).

where the dummy variable, $Covid\ period_t$ takes the value 1 for all firm-day observations from March 2020 to June 2020 and 0 otherwise. The coefficients are estimated with respect to the *Pre-covid period*. We expect both β_4 and β_5 to be negative and significant, in line with Hypothesis 2d.

In an alternative specification, along with identifying the pandemic period, which represents the months with heightened uncertainty, we also identify and estimate the likely effect during a *Post covid period*. This period, which spans from July 2020 to September 2021 (until the end of the sample period) represents a return to relative normalcy, compared to the *Covid period*. We expect the attention to the earnings announcements to return to similar levels as in the *Pre-covid period*, during this period. To test if the lower impact of earnings announcements was only a characteristic of the *Covid period* and the impact returned to the *Pre-covid* levels in the *Post covid period*, we use the specification below:

$$\begin{aligned} RiskInfo_{i,k,t} = \beta_0 &+ \beta_1 \times Own\ period_t + \beta_2 \times Peer\ firm\ announcement_t \\ &+ \beta_3 \times Index\ riskinfo_t + \beta_4 \times Own\ period_t \times Period_t \\ &+ \beta_5 \times Peer\ firm\ announcement_t \times Period_t \\ &+ \beta_6 \times Index\ riskinfo_t \times Period_t \\ &+ \Sigma_{z=1}^{N} \eta_z \times Y_{i,k,t} + \delta_i + \theta_{k,q} + \epsilon_{i,t} \end{aligned} \tag{10}$$

where $Period_t$ is a factor variable with 3 levels. Level 0 represents the *Pre-covid period*. Level 1, identified as *Covid period*, represents the firm-day observations from March 2020 to June 2020, analogous to Equation 9. Level 2, identified as *Post covid period*. represents the firm-day observations from July 2020 to September 2021. In line with Hypothesis 2d, we expect β_4 and β_5 to be statistically insignificant (negative and significant) in the *Post covid period* (*Covid period*). This would indicate that the impact of earnings announcements returned to the *Pre-covid* levels in the *Post covid period*.

The results of the DiD estimations are given in Table 9. The results of the estimations of

Equation 9 are shown in columns (1) and (2). The coefficients of *Own period* × *Covid period* and *Peer firm announcement* × *Covid period* are significantly negative in both the columns. This indicates that the earnings announcements had a significantly lower impact on the firm risk information during periods of high uncertainty after the onset of the pandemic. The magnitude of reduction in the impact of the announcements in the *Covid period* is similar to the impact in the *Pre-covid period*. For instance, while the coefficient of *Own period* is 0.22 in column (2), the coefficient of *Own period* × *Covid period* is -0.15, indicating no significant impact of own earnings announcements in the pandemic period. These findings are in line with Hypothesis 2d. Prior research finds that in times of heightened uncertainty, asset prices tend to co-move to a greater degree as investors focus on market-wide events instead of firm-specific events (Barber and Odean, 2008; Boyer et al., 2006). We, therefore, provide novel evidence in support of lower attention to firm-specific news in a crisis period, using the COVID-19 period as an exogenous shock and a direct measurement of innovations in risk.

In columns (3) and (4) we present the results for the estimation of Equation 10. As shown, while the coefficients of *Own period* × *Covid period* and *Peer firm announcement* × *Covid period* are largely unchanged compared to those in columns (1) and (2). The coefficients of both *Own period* × *Post covid period* and *Peer firm announcement* × *Post covid period* are not significant. The comparison of the coefficients suggests that, relative to the *Pre-covid period*, the baseline against which the coefficients are estimated, the impact of earnings announcements on risk information is not significantly different. Our findings, therefore, imply that once the markets returned to relative normalcy, the impact of earnings announcements on risk information has returned to Pre-covid levels.

On the other hand, we also find that the impact of market-wide risk information on firm risk information has not changed significantly during the pandemic period. For instance, the coefficient of *Index riskinfo* × *Covid period* is not significant (in column (4)). This is in line with our earlier findings (in Section 4.3) where we observe that while the impact of

market-wide risk information on firm risk information declines in good market conditions, it does not increase during relatively poor market conditions.

In an alternative specification, we shorten the *Pre-covid period* by including only the firm-day observations from January 2019 to September 2021. Although we control for the year-quarter fixed effects, we believe that restricting the *Pre-covid period* approximately to a year before the crisis ensures the robustness of our results. The results of the estimation of Equation 9 and Equation 10 for the shortened *Pre-covid period* are presented in Table 10. Our findings on the change in the impact of earnings announcements and the market-wide risk information on firm risk information remain largely similar to those presented in the baseline estimation (Table 9).

Overall, first, we find that firm-level announcements matter less in the COVID-19 crisis period compared to a prior period in determining the innovations in risk of a firm. Simultaneously, the correlation of the firm risk information with market-wide risk information is unaffected. The two findings point to a shift in investor focus from beta risk information to market-wide risk information.

These findings on the change of the impact of firm-level disclosures on firm risk information are consistent with lower investor attention in times of increased intensity of macroeconomic announcements compared to normal times (Barber and Odean, 2008; Boyer et al., 2006). It is also in line with rational inattention to firm-specific news in times of crisis as they have lower pricing relevance during such periods (see Veldkamp, 2006) and irrational inattention to price-sensitive information when a distracting event occurs (Peng and Xiong, 2006; Hirshleifer et al., 2009). Prior research also shows that investors sought lower firm-specific information during the COVID-19 crisis (Dong et al., 2021). Our findings provide evidence of lower attention to firm-specific news during the pandemic period, employing a direct measure of risk information.

5 Robustness

In this section, we carry out several empirical tests to examine the robustness of our results related to firm-level risk information as impacted by earnings announcements and market-wide risk information, during normal and uncertain periods. Firstly, we employ an alternative measure of *Riskinfo*, where the event risk correction is measured two days before the event, as suggested by Smith and So (2022). Secondly, instead of employing signed values of risk information as in *Riskinfo*, we examine the impact that the two sources of risk information have on the absolute value of risk information. An absolute measure of risk information is important as events such as earnings announcements can be potentially risk-decreasing events and therefore an impact on firm risk information of either sign is possible. Finally, we re-estimate the key results with a sub-sample. Particularly, we adopt a sub-sample of days within each month included in the normal period sample. We discuss the results of the robustness estimations in the following sections.

5.1 Impact on firm risk information with alternative measure of event risk

The results of the estimation employing Equation 5 with risk information corrected for the event risk two days before the event, are presented in Table 11. As observed earlier for the normal period, the coefficient of *Peer firm announcement* is positive and significant with the alternative measure of risk information. The magnitude of the coefficient is approximately a fourth of that of *Own period*, in line with the findings in Section 4.1. Similarly, the coefficient of *Index riskinfo two day* is positive and significant and its magnitude is comparable to the corresponding coefficient in Table 3. The results of the estimation of Equation 9 and Equation 10 are shown in Table 12. The results of the DiD estimation are also broadly consistent with those reported in Section 4.4. Therefore, our results are robust to how risk information is corrected for the event risk.

5.2 Estimations with the absolute value of risk information

The results of the analysis so far suggest that firm risk information is generally higher on the days of earnings announcements of a firm or those of its industry peers. However, it is possible that some of the announcements reduce the fundamental risk of the firm and consequently lead to a negative value of the firm risk information on the day of an earnings announcement. Although our results suggest that event days generally lead to an increase in the firm risk,[5] we examine if our results hold when an absolute value of risk information is employed in the estimates.

For the robustness analysis, we estimate two new variables, the absolute value of risk information, *AbsRiskinfo*, and the absolute value of market risk information *AbsIndex riskinfo*. The absolute value function will convert large negative values of risk information into large positive values and will therefore enable us to examine if earnings announcements *change* the firm risk rather than *increase* it. The estimation with the absolute risk information is carried out for both the normal period and the pandemic period. The results of the estimation are presented in Table 13 for the baseline sample and Table 14 for the DiD specification involving the pandemic period.

For the normal period, as observed in estimations with $Riskinfo$, the coefficients of both *Own period* and $Peer\ firm$ *announcement* are positive and significant. The mean value of the mean value of *AbsIndex riskinfo* is 0.28%. Therefore a firm's own earnings announcement leads to an increase in *AbsIndex riskinfo* by approximately 42%. Similarly, a peer firm's earnings announcement also leads to an increase in *AbsIndex riskinfo* by approximately 15%. These findings consistent with those obtained with signed risk information, indicate that earnings announcement days significantly *change* the risk of a firm. The change in risk can potentially be an increase or decrease in risk.

During the pandemic period, the impact of the earnings announcements on absolute firm

[5]For instance, Figure 1 shows that in the Pre-covid period, the firm risk information distribution on event days is shifted to the right, relative to that on non-event days.

risk information was reduced, in line with our findings in Section 4.4. The coefficients of *Own period* × *Covid period* and *Peer firm announcement* × *Covid period* are both negative and significant in all columns in Table 14. Therefore, our results are robust to an alternative estimation that measures the change in risk instead of an increase in risk.

5.3 Firm risk information - Sub-sample analysis

We divide our normal period sample into different sub-samples and examine if our results in Section 4.1 hold in each of the sub-samples. For this purpose, we first create the sub-samples by dividing the firm-day observations into those from the first half of a year and those from the second half of the year and re-estimate the specification in Equation 5. The results of the estimation are shown in Table 15, Panel A. As shown, the coefficients of *Own period* and *Peer firm announcement* remain statistically significant and comparable in magnitude to those in Table 3 in both the sub-samples. Moreover, the coefficient of *Index riskinfo* also remains statistically significant in both sub-samples.

We also create sub-samples by dividing the observations into those during the two-year range from 2016 to 2017 and those during the two years from 2018 to 2019 and re-estimate the specification in Equation 5. The results are presented in Table 15, Panel B. As shown, the coefficients are largely similar in both sub-samples and are comparable to those in Table 3. Therefore, our results hold in different sub-samples within the data.

6 Conclusion

The paper examines how discount rate information is inferred from different sources by the market both in normal and turbulent market conditions. The paper focuses on two theoretically motivated sources of risk information, earnings announcements of firms and the changes in the equity market risk premium. We use a recently proposed, option-derived measure to estimate risk information. It is claimed that this measure captures the changes

in equity risk more cleanly than some of the existing measures (Smith and So, 2022).

Our key findings and their implications are as follows. First, we show that on the days of a peer firm's earnings announcement, the risk information of a non-announcing firm is approximately six times greater than that on an average day. This indicates that investors learn risk-relevant information from a peer firm's earnings announcement. Our result is robust to controlling for a firm's announcement period. Own announcements contain significant risk information, about twenty times that of an average day as reported by Smith and So (2022). The result indicates that investors learn significantly about fundamental risk information from a peer firm's earnings announcement.

Second, we find that in quarters characterised by high market returns, the positive correlation between the firm and market risk information is lower. The finding is consistent with a lower (higher) risk aversion among investors in good (bad) market conditions. Third, we show that even under good market conditions, firms with a higher ex-ante market risk have a greater sensitivity to innovations in market risk information. It indicates that although good market conditions lead to a lower correlation between the market and the firm risk information, consistent with a lower risk aversion, the discounting rate of riskier firms continues to remain exposed to a greater degree to innovations in the market risk.

Finally, we employ the COVID-19 crisis as an exogenous shock to further examine how the magnitude of risk information from the two sources, firm-level earnings announcements, and the market-wide risk information, changes during times of crisis. We find that the impact on the risk information from the firm's own earnings announcements and peer firm's announcements is greatly lowered during the COVID-19 period. This implies lower attention to firm-specific news during heightened market uncertainty. Furthermore, we find that the impact of market-wide risk information on firm risk information is not significantly different in the COVID-19 period compared to normal times. The consistent significance of market-wide risk as compared to the diminished role of firm-specific risk is in line with rational and irrational inattention to firm-specific news in times of crisis.

Our findings indicate a significant time variation in the investors' absorption of firm-specific and market-wide discount rate news into the stock-level discount rates and thereby into stock prices. The innovations in the market risk premium are absorbed readily in times of a systemic crisis, consistent with rational inattention to firm-specific news in times when the market-wide news is readily available and arguably more relevant for changes in the discount rate. On the other hand, firms' earnings announcements and peer firms' earnings announcements, which provide significant discount rate news in normal times, receive lower attention in crisis periods.

References

Agarwalla, S. K., Varma, J. R., and Virmani, V. (2021). The impact of covid-19 on tail risk: Evidence from nifty index options. *Economics Letters*, 204:109878.

Alfaro, L., Chari, A., Greenland, A. N., and Schott, P. K. (2020). Aggregate and firm-level stock returns during pandemics, in real time. Technical report, National Bureau of Economic Research.

Ball, R. and Brown, P. (1968). An empirical evaluation of accounting income numbers. *Journal of accounting research*, pages 159–178.

Bansal, A., Gopalakrishnan, B., Jacob, J., and Srivastava, P. (2022). Impact of operational fragility on stock returns: Lessons from covid-19 crisis. *International Review of Finance*.

Barber, B. M. and Odean, T. (2008). All that glitters: The effect of attention and news on the buying behavior of individual and institutional investors. *The review of financial studies*, 21(2):785–818.

Barberis, N., Huang, M., and Santos, T. (2001). Prospect theory and asset prices. *The quarterly journal of economics*, 116(1):1–53.

Barth, M. E. and So, E. C. (2014). Non-diversifiable volatility risk and risk premiums at earnings announcements. *The Accounting Review*, 89(5):1579–1607.

Bordalo, P., Gennaioli, N., and Shleifer, A. (2012). Salience theory of choice under risk. *The Quarterly journal of economics*, 127(3):1243–1285.

Boyer, B. H., Kumagai, T., and Yuan, K. (2006). How do crises spread? evidence from accessible and inaccessible stock indices. *The journal of finance*, 61(2):957–1003.

Brochet, F., Kolev, K., and Lerman, A. (2018). Information transfer and conference calls. *Review of Accounting Studies*, 23(3):907–957.

Campbell, J. Y. and Shiller, R. J. (1988). The dividend-price ratio and expectations of future dividends and discount factors. *The Review of Financial Studies*, 1(3):195–228.

Campbell, J. Y. and Vuolteenaho, T. (2004). Bad beta, good beta. *American Economic Review*, 94(5):1249–1275.

Chan, K., Chung, Y. P., and Johnson, H. (1993). Why option prices lag stock prices: A trading-based explanation. *The Journal of Finance*, 48(5):1957–1967.

Chiang, T. C. and Zheng, D. (2010). An empirical analysis of herd behavior in global stock markets. *Journal of Banking & Finance*, 34(8):1911–1921.

Christensen, B. J. and Prabhala, N. R. (1998). The relation between implied and realized volatility. *Journal of financial economics*, 50(2):125–150.

Cochrane, J. H. (2011). Presidential address: Discount rates. *The Journal of finance*, 66(4):1047–1108.

Cohen, L. and Frazzini, A. (2008). Economic links and predictable returns. *The Journal of Finance*, 63(4):1977–2011.

Cohen, R. B., Polk, C., and Vuolteenaho, T. (2003). The value spread. *The Journal of Finance*, 58(2):609–641.

Cohn, A., Engelmann, J., Fehr, E., and Maréchal, M. A. (2015). Evidence for countercyclical risk aversion: An experiment with financial professionals. *American Economic Review*, 105(2):860–85.

Da, Z., Engelberg, J., and Gao, P. (2011). In search of attention. *The journal of finance*, 66(5):1461–1499.

Dennis, P., Mayhew, S., and Stivers, C. (2006). Stock returns, implied volatility innovations, and the asymmetric volatility phenomenon. *Journal of Financial and Quantitative Analysis*, 41(2):381–406.

Ding, W., Levine, R., Lin, C., and Xie, W. (2021). Corporate immunity to the covid-19 pandemic. *Journal of Financial Economics*, 141(2):802–830.

Dong, H., Gil-Bazo, J., and Ratiu, R. V. (2021). Information demand during the covid-19 pandemic. *Journal of Accounting and Public Policy*, 40(6):106917.

Dubinsky, A., Johannes, M., Kaeck, A., and Seeger, N. J. (2019). Option pricing of earnings announcement risks. *The Review of Financial Studies*, 32(2):646–687.

Foster, G. (1981). Intra-industry information transfers associated with earnings releases. *Journal of accounting and economics*, 3(3):201–232.

Frederickson, J. R. and Zolotoy, L. (2016). Competing earnings announcements: Which announcement do investors process first? *The Accounting Review*, 91(2):441–462.

Gatheral, J. (2011). *The volatility surface: a practitioner's guide*. John Wiley & Sons.

Gopalakrishnan, B., Jacob, J., and Mohapatra, S. (2022). Covid-19 pandemic and debt financing by firms: Unravelling the channels. *Economic Modelling*, 114:105929.

Guiso, L., Sapienza, P., and Zingales, L. (2018). Time varying risk aversion. *Journal of Financial Economics*, 128(3):403–421.

Hameed, A., Morck, R., Shen, J., and Yeung, B. (2015). Information, analysts, and stock return comovement. *The Review of Financial Studies*, 28(11):3153–3187.

Hann, R. N., Kim, H., and Zheng, Y. (2019). Intra-industry information transfers: evidence from changes in implied volatility around earnings announcements. *Review of Accounting Studies*, 24(3):927–971.

Hassan, T. A., Hollander, S., Van Lent, L., Schwedeler, M., and Tahoun, A. (2020). Firm-level exposure to epidemic diseases: Covid-19, sars, and h1n1. Technical report, National Bureau of Economic Research.

Hertzel, M. G. and Officer, M. S. (2012). Industry contagion in loan spreads. *Journal of Financial Economics*, 103(3):493–506.

Hirshleifer, D., Lim, S. S., and Teoh, S. H. (2009). Driven to distraction: Extraneous events and underreaction to earnings news. *The Journal of Finance*, 64(5):2289–2325.

Hoffmann, A. O., Post, T., and Pennings, J. M. (2013). Individual investor perceptions and behavior during the financial crisis. *Journal of Banking & Finance*, 37(1):60–74.

Kothari, S. (2001). Capital markets research in accounting. *Journal of accounting and economics*, 31(1-3):105–231.

Pandit, S., Wasley, C. E., and Zach, T. (2011). Information externalities along the supply chain: The economic determinants of suppliers' stock price reaction to their customers' earnings announcements. *Contemporary Accounting Research*, 28(4):1304–1343.

Patell, J. M. and Wolfson, M. A. (1979). Anticipated information releases reflected in call option prices. *Journal of accounting and economics*, 1(2):117–140.

Patell, J. M. and Wolfson, M. A. (1981). The ex ante and ex post price effects of quarterly earnings announcements reflected in option and stock prices. *Journal of Accounting Research*, pages 434–458.

Peng, L. and Xiong, W. (2006). Investor attention, overconfidence and category learning. *Journal of Financial Economics*, 80(3):563–602.

Penman, S. H. and Yehuda, N. (2019). A matter of principle: Accounting reports convey both cash-flow news and discount-rate news. *Management Science*, 65(12):5584–5602.

Ramelli, S. and Wagner, A. F. (2020). Feverish stock price reactions to covid-19. *The Review of Corporate Finance Studies*, 9(3):622–655.

Rogers, J. L., Skinner, D. J., and Van Buskirk, A. (2009). Earnings guidance and market uncertainty. *Journal of Accounting and Economics*, 48(1):90–109.

Smith, K. C. and So, E. C. (2022). Measuring risk information. *Journal of Accounting Research*, 60(2):375–426.

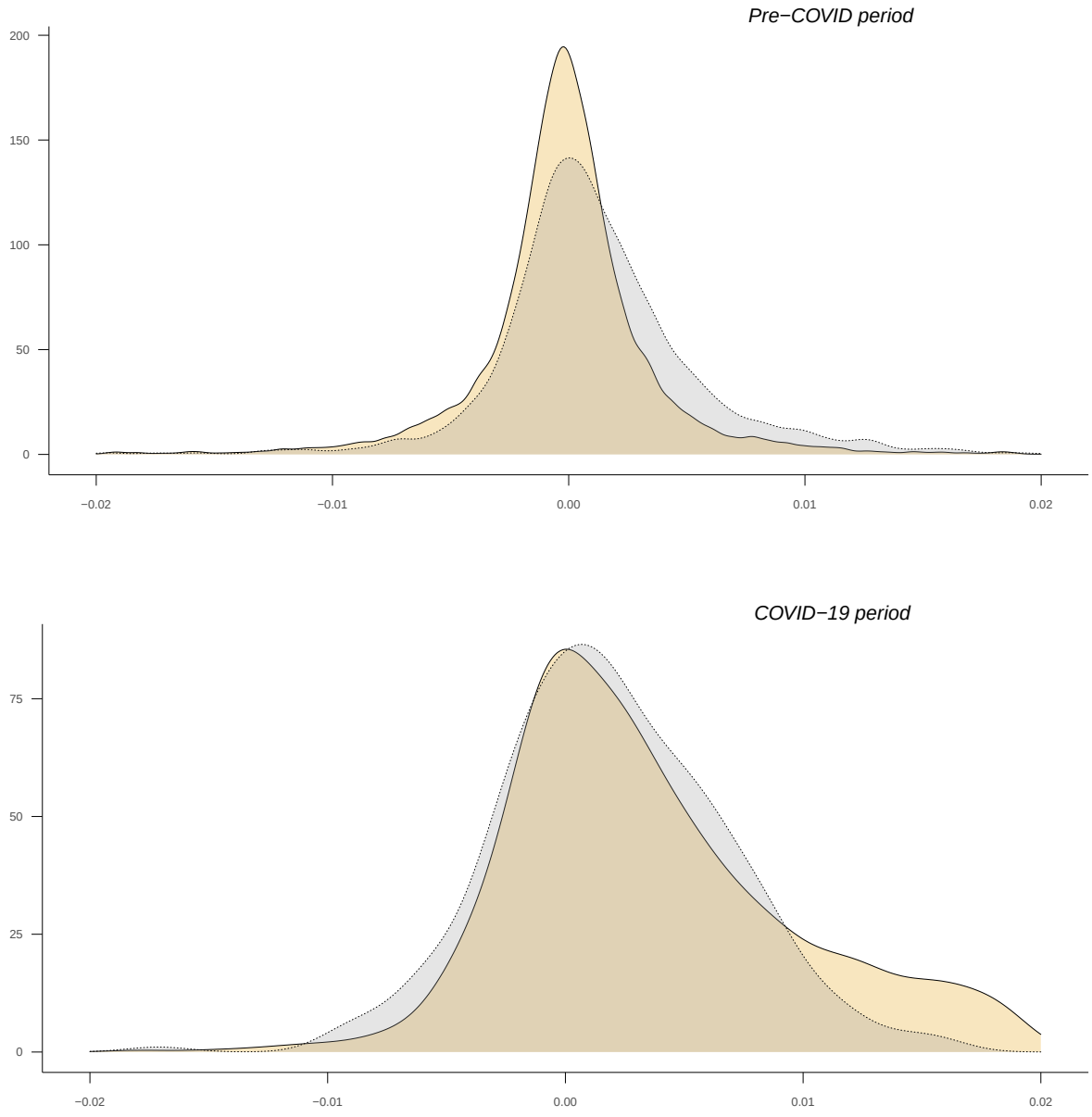
Stambaugh, R. F., Yu, J., and Yuan, Y. (2015). Arbitrage asymmetry and the idiosyncratic volatility puzzle. *The Journal of Finance*, 70(5):1903–1948.

Thomas, J. and Zhang, F. (2008). Overreaction to intra-industry information transfers? *Journal of Accounting Research*, 46(4):909–940.

Veldkamp, L. L. (2006). Information markets and the comovement of asset prices. *The Review of Economic Studies*, 73(3):823–845.

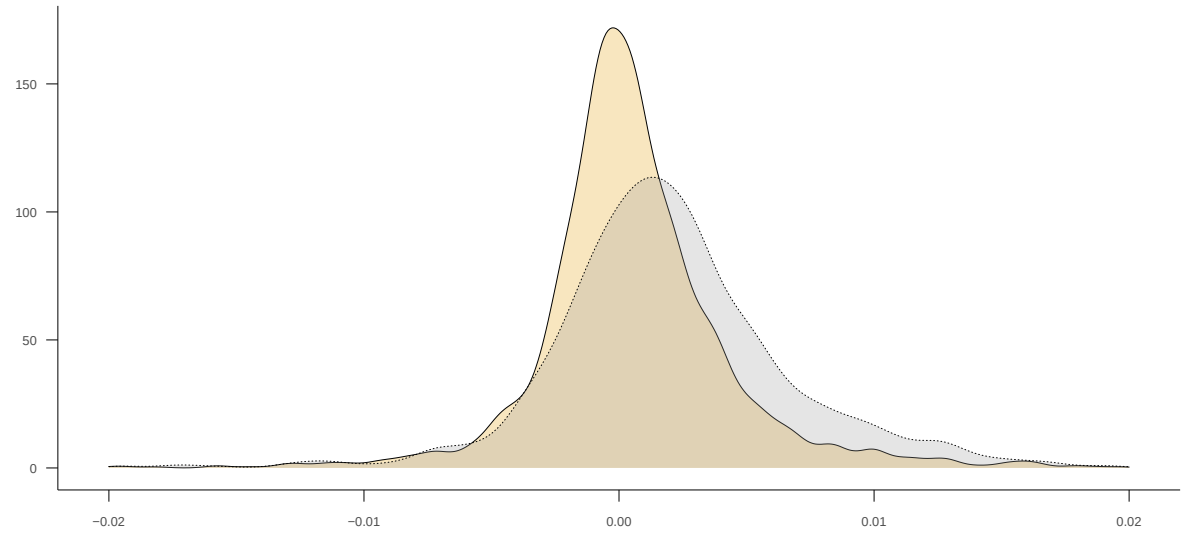
Verrecchia, R. E. (1983). Discretionary disclosure. *Journal of accounting and economics*, 5:179–194.

Figure 1: **Distribution of *Riskinfo* on even and non-event days**



The figures plot the distribution of *Riskinfo* on event days (Grey-Dotted) and non event days(Yellow-Solid). $Riskinfo_{i,t}$ corresponds to an event day on days t when either *Peer firm announcement* or *Own period* takes the value one. *Riskinfo* corresponding to all other days belong to non event days. Variables are defined in Table 1.

Figure 2: **Distribution of** *Riskinfo* **in *Own period* and the days of a *Peer firm announcement***



The figures plot the distribution of $Riskinfo_{i,t}$ corresponding to days t days when *Own period* takes the value 1 (Grey-Dotted) and *Peer firm announcement* takes the value 1 (Yellow-Solid). Variables are defined in Table 1.

Table 1: **Variable definitions and data sources**

Variable	Definition and construction	Data source
Measures of risk information:		
Riskinfo	The *Riskinfo* for a firm-day, estimated using Equation 4 in Section 3, with $k = 1$	NSE
Riskinfo (2 day)	The *Riskinfo* for a firm-day, estimated using Equation 4 in Section 3, with $k = 2$	NSE
Index riskinfo	The *Riskinfo* for an index-day, estimated using Equation 4 in Section 3, with $k = 1$	NSE
Index riskinfo (2 day)	The *Riskinfo* for an index-day, estimated using Equation 4 in Section 3, with $k = 2$	NSE
Firm characteristics:		
Mcap	Natural logarithm of the market capitalization of a firm on the last day of the financial year immediately prior to the date in consideration (in INR Crores).	CMIE Prowess
BM	The ratio of the book-value per share to the market value per share of a firm on the last day of the financial year immediately prior to the date in consideration	CMIE Prowess
Beta	The regression coefficient of a firm's monthly returns against the returns of the market, proxied by the NIFTY index. The regression has 36 prior monthly observations until the month of the date in consideration	CMIE Prowess
Ivol	The volatility of the error coefficients of a regression of a firm's monthly returns against the returns of the market, proxied by the NIFTY index. The regression has 36 prior monthly observations until the month of the date in consideration	CMIE Prowess
Others:		
Peer firm announcement	A dummy variable which takes the value 1 if it is the announcement day of a big peer firm of the firm in consideration, say firm $'i'$, and 0 otherwise. We define a big peer firm as the following. It is a firm in the top decile of market capitalization distribution of the firms in the same two digit NIC as the firm i. We drop observations that are within a 10 day window of firm $i's$ own announcement	CMIE Prowess

Continued on next page

Table 1 – *Continued from previous page*

Variables	Definition and construction	Data source
Small peer announcement	A dummy variable which takes the value 1 if it is the announcement day of a small peer firm of the firm in consideration, say firm $'i'$, and 0 otherwise. We define a small peer firm as the following. It is a firm not in the top decile of market capitalization distribution of the firms in the same two digit NIC as the firm i. We drop observations that are within a 10 day window of firm $i's$ own announcement	CMIE Prowess
Own period	For a firm day, a dummy variable that takes the value 1 if the day is within a 5 day window of firm's own announcement day and 0 otherwise	CMIE Prowess
Time to maturity	For a firm day, the time remaining to maturity as a fraction of 365 days, for the shorter maturity option involved in the estimation of the $Riskinfo$ variables	CMIE Prowess
Ivol	The volatility of the error coefficients of a regression of a firm's monthly returns against the returns of the market, proxied by the NIFTY index. The regression has 36 prior monthly observations until the month of the date in consideration	CMIE Prowess

Table 2: Summary statistics

Statistic	Mean	St. Dev.	Median	Min	Max	N
	Panel A - Normal period					
Time to maturity	3.502	1.619	2.740	1.370	8.219	16,942
Riskinfo	0.019	0.499	0.0003	−4.255	4.002	16,942
Riskinfo two day	0.018	0.478	0.008	−4.127	3.716	16,942
Own period	0.095	0.293	0	0	1	16,942
Index riskinfo	−0.030	0.178	−0.024	−1.741	0.584	16,942
Index riskinfo two day	−0.027	0.164	−0.025	−1.333	0.647	16,942
Beta	1.229	0.565	1.214	−0.011	2.461	16,942
Mcap	11.243	1.134	11.308	8.702	13.529	16,942
BM	2.226	3.946	0.734	0.040	23.256	16,942
Peer firm announcement	0.126	0.332	0	0	1	16,942
	Panel B - Covid period and Post covid period					
Time to maturity	4.098	1.709	4.110	1.644	8.219	9,333
Riskinfo	0.076	0.588	0.027	−3.916	3.994	9,333
Riskinfo two day	0.072	0.562	0.032	−4.090	3.770	9,333
Own period	0.083	0.276	0	0	1	9,333
Index riskinfo	−0.050	0.303	−0.066	−2.534	1.819	9,333
Index riskinfo two day	−0.053	0.304	−0.061	−2.488	1.921	9,333
Beta	1.366	0.766	1.243	0.243	2.919	9,333
Mcap	11.264	1.108	11.325	8.838	13.977	9,333
BM	3.014	5.346	0.967	0.031	47.393	9,333
Peer firm announcement	0.143	0.350	0	0	1	9,333

Note: *Time to maturity* is measured as a fraction of 365 days. *Std. Dev.* represents standard deviation of variables. All variables except *Own period*, *Beta*, *Mcap* and *Top quintile announcement* are multiplied with 100. Variable definitions are provided in Table 1.

Table 3: Firm risk information from earnings announcements

Var	*Riskinfo*			
	(1)	(2)	(3)	(4)
Own period	0.23***	0.234***	0.232***	0.226***
	(0.013)	(0.0254)	(0.0241)	(0.0225)
Peer firm announcement	0.07***	0.081***	0.081***	0.072***
	(0.0115)	(0.0252)	(0.0253)	(0.018)
Time to maturity	-1.427***	-1.419	-1.574**	-1.669***
	(0.2343)	(0.8345)	(0.7038)	(0.5912)
Index riskinfo			42.979***	42.66***
			(4.892)	(3.9862)
Constant	0.038***	0.036	0.054*	0.059**
	(0.0092)	(0.0313)	(0.0273)	(0.0226)
Firm fixed effects	No	Yes	Yes	Yes
Year quarter fixed effects	No	Yes	Yes	Yes
Industry year qtr fixed effects	No	No	No	Yes
N	16942	16942	16942	16942
R^2	0.02052	0.0418	0.06334	0.09649

Note: The dependent variable in columns (1) - (4) is *Riskinfo*, estimated using Equation 4 in Section 3, with $k = 1$. *Own period* is a dummy variable that takes the value 1 if the day is within a 5 day window of firm's own announcement day and 0 otherwise. *Peer firm announcement* A dummy variable which takes the value 1 if it is the announcement day of a big peer firm of the firm in consideration, say firm $'i'$, and 0 otherwise. We define a big peer firm as the following. It is a firm in the top quintile of market capitalization distribution of the firms in the same two digit NIC as the firm i. We drop observations that are within a 10 day window of firm $i's$ own announcement. *Time to maturity* is the time remaining to maturity as a fraction of 365 days, for the shorter maturity option involved in the estimation of the $Riskinfo$ variables. *Index riskinfo* for an index-day is estimated using Equation 4 in Section 3, with $k = 1$. All coefficients are in percentage. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 4: Firm risk information from earnings announcements - Small and large peers

Var	*Riskinfo*			
	(1)	(2)	(3)	(4)
Own period	0.243 ***	0.249 ***	0.245 ***	0.238 ***
	(0.0132)	(0.0295)	(0.0274)	(0.0232)
Peer firm announcement	0.082 ***	0.099 ***	0.097 ***	0.087 ***
	(0.0118)	(0.0295)	(0.0292)	(0.0186)
Smaller peer announcement	0.064 ***	0.07 **	0.061 **	0.058 ***
	(0.0107)	(0.0291)	(0.0243)	(0.015)
Time to maturity	-1.511 ***	-1.487 *	-1.632 **	-1.724 ***
	(0.2345)	(0.8307)	(0.6986)	(0.5928)
Index riskinfo			42.525 ***	42.228 ***
			(5.0607)	(3.8716)
Constant	0.028 ***	0.024	0.043	0.049 **
Firm fixed effects	No	Yes	Yes	Yes
Year quarter fixed effects	No	Yes	Yes	Yes
Industry year qtr fixed effects	No	No	No	Yes
N	16942	16942	16942	16942
R^2	0.02241	0.04404	0.06509	0.09797

Note: The dependent variable in columns (1) - (4) is *Riskinfo*. *Small peer announcement* A dummy variable which takes the value 1 if it is the announcement day of a small peer firm of the firm in consideration, say firm $'i'$, and 0 otherwise. We define a small peer firm as the following. It is a firm not in the top decile of market capitalization distribution of the firms in the same two digit NIC as the firm i. We drop observations that are within a 10 day window of firm $i's$ own announcement . All other variables are defined in Table 1. All coefficients are in percentage. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 5: Firm risk information from earnings announcements - Impact of *Ivol*

Var	*Riskinfo*			
	(1)	(2)	(3)	(4)
Own period	0.113***	0.114*	0.12*	0.117**
	-0.0263	-0.0578	-0.0593	-0.0497
Ivol	2.466	3.204	3.379	5.275
	-1.8084	-3.2814	-3.3011	-7.346
Own period × *Ivol*	27.983***	27.203*	25.503*	26.341**
	-5.4847	-13.1288	-13.4436	-12.0445
Peer firm announcement	0.002	-0.003	0.001	0.015
	-0.0218	-0.0573	-0.0564	-0.0495
Peer firm announcement × *Ivol*	16.509***	16.994	16.17	13.88
	-4.5122	-14.747	-14.8734	-12.9287
Time to maturity	-1.445***	-1.508*	-1.671**	-1.669***
	-0.2341	-0.7475	-0.6007	-0.5205
Index riskinfo			42.669***	42.36***
			-4.4289	-3.3738
Constant	0.028**	0.028	0.046*	0.037
	-0.012	-0.0294	-0.0249	-0.0373
Year quarter fixed effects	No	Yes	Yes	Yes
Industry year qtr fixed effects	No	No	No	Yes
N	16942	16942	16942	16942
R^2	0.02366	0.03068	0.05186	0.07255

Note: The dependent variable in columns (1) - (4) is *Riskinfo*. *Ivol* is the volatility of the error coefficients of a regression of a firm's monthly returns against the returns of the market, proxied by the NIFTY index. The regression has 36 prior monthly observations until the month of the date in consideration All other variables are defined in Table 1. All coefficients are in percentage. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 6: Firm risk information and market-wide risk information - Impact of firm characteristics

Var	*Riskinfo*	
	(1)	(2)
Index riskinfo	0.54827**	0.40335
	(0.254)	(0.303)
BM	0.00349***	0.00009
	(0.001)	(0.005)
*Index riskinfo * BM*	-1.58213***	-0.89123
	(0.281)	(0.584)
Mcap	0.00009**	-0.00003
	(0.000)	(0.000)
*Index riskinfo * Mcap*	-0.02551	-0.01594
	(0.020)	(0.023)
Beta	0.00007	0.00046
	(0.000)	(0.000)
*Index riskinfo * Beta*	0.19472***	0.19415***
	(0.043)	(0.062)
Time to maturity	-0.01715***	-0.01715***
	(0.002)	(0.006)
Own period	0.00217***	0.00213***
	(0.000)	(0.000)
Constant	-0.00047	0.0005
	(0.000)	(0.005)
Firm fixed effects	No	Yes
Year quarter fixed effects	No	Yes
Industry year qtr fixed effects	No	Yes
N	16942	16942
R^2	0.04943	0.09639

Note: The dependent variable in columns (1) - (2) is *Riskinfo*. *BM* is ratio of the book-value per share to the market value per share of a firm on the last day of the financial year immediately prior to the date in consideration. *Mcap* is the natural logarithm of the market capitalization of a firm on the last day of the financial year immediately prior to the date in consideration (in INR Crores). All other variables are defined in Table 1. All coefficients are in percentage. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 7: Firm risk information and market-wide risk information - Impact of phases of the market

Var	*Riskinfo*			
	(1)	(2)	(3)	(4)
Own period	0.226***	0.232***	0.225***	0.231***
	(0)	(0)	(0)	(0)
Peer firm announcement	0.065***	0.076***	0.064***	0.075***
	(0)	(0)	(0)	(0)
Index riskinfo	42.986***	43.042***	54.598***	55.252***
	(2.1)	(3.9)	(4.7)	(5)
Market return	-0.615***	-0.623***		
	(0.1)	(0.1)		
Index riskinfo × *Market return*	-192.014***	-209.517**		
	(70.7)	(85.8)		
Time to maturity	-1.628***	-1.627***	-1.645***	-1.641***
	(0.2)	(0.6)	(0.2)	(0.6)
Ivol	7.627***	27.019*	7.559***	26.778*
	(1.6)	(13.6)	(1.6)	(13.6)
Market return quartile 2			-0.042***	-0.043**
			(0)	(0)
Market return quartile 3			-0.058***	-0.058***
			(0)	(0)
Market return quartile 4			-0.046***	-0.048***
			(0)	(0)
Index riskinfo × *Market return quartile 2*			-4.704	-5.573
			(6.2)	(12.4)
Index riskinfo × *Market return quartile 3*			-21.35***	-21.854***
			(5.8)	(6.7)
Index riskinfo × *Market return quartile 4*			-19.554**	-21.592**
			(8.1)	(10.2)
Constant	0.031***	-0.052	0.064***	-0.018
	(0)	(0.1)	(0)	(0.1)
Firm fixed effects	No	Yes	No	Yes
N	16942	16942	16942	16942
R^2	0.04874	0.06725	0.04884	0.06733

Note: The dependent variable in columns (1) - (4) is *Riskinfo*. *Market return quartile k* is the 'kth' quartile of the NIFTY quarterly return for all quarters from January 2016 to December 2019, where k is one of 1,2,3 and 4, with *Market return quartile 4* being the highest quartile of returns. All other variables are defined in Table 1. All coefficients are in percentage. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 8: Firm risk information and market-wide risk information - Impact of phases of the market and firm characteristics

Var	*Riskinfo*		
	(1)	(2)	(3)
Own period	0.224***	0.23***	0.23***
	(0)	(0)	(0)
Peer firm announcement	0.066***	0.075***	0.073***
	(0)	(0)	(0)
Index riskinfo	18.951***	19.156**	65.538*
	(5.2)	(8.9)	(38.9)
Market return	-0.401*	-0.352	-0.155
	(0.2)	(0.3)	(2.1)
Index riskinfo × *Market return*	-670.755***	-651.905***	-425.619
	(167)	(185.8)	(1232)
Beta	-0.006	0.027	0.028
	(0)	(0)	(0)
Index riskinfo × *Beta*	20.602***	20.358***	16.323**
	(4.1)	(6.7)	(6.5)
Market return × *Beta*	-0.165	-0.214	-0.304
	(0.2)	(0.3)	(0.3)
Index riskinfo × *Market return* × *Beta*	376.021***	349.122***	339.048**
	(119.1)	(119.1)	(133.2)
Time to maturity	-1.642***	-1.645***	-1.695***
	(0.2)	(0.6)	(0.6)
Ivol	8.845***	26.484*	18.915**
	(1.6)	(13.8)	(7.4)
BM			0.744
			(0.8)
Index riskinfo × *BM*			-144.802
			(103)
Market return × *BM*			6.057
			(8.7)
Index riskinfo × *Market return* × *BM*			-1123.747
			(4144.4)
Mcap			-0.003
			(0)
Index riskinfo × *Mcap*			-3.261
			(3)
Market return × *Mcap*			-0.015
			(0.2)
Index riskinfo × *Market return* × *Mcap*			-17.325
			(99.1)
Constant	0.034***	-0.081	-0.038
	(0)	(0.1)	(0.5)
Firm fixed effects	No	Yes	Yes
N	16942	16942	16942
R^2	0.05124	0.06943	0.07581

Note: The dependent variable in columns (1) - (3) is *Riskinfo*. All other variables are defined in Table 1.All coefficients are in percentage. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 9: Firm risk information - COVID-19 period

Var	*Riskinfo*			
	(1)	(2)	(3)	(4)
Own period	0.22***	0.22***	0.22***	0.219***
	(0.013)	(0.0222)	(0.0128)	(0.0221)
Covid period	0.335***	1.136***	0.336***	1.141***
	(0.0177)	(0.1235)	(0.0174)	(0.1239)
Own period × *Covid period*	-0.373***	-0.15***	-0.373***	-0.172***
	(0.0548)	(0.0404)	(0.054)	(0.0392)
Peer firm announcement	0.065***	0.071***	0.065***	0.071***
	(0.0115)	(0.0164)	(0.0113)	(0.0164)
Peer firm announcement × *Covid period*	-0.203***	-0.096***	-0.203***	-0.089***
	(0.0432)	(0.0261)	(0.0425)	(0.0269)
Index riskinfo	42.058***	40.628***	41.986***	40.656***
	(2.1201)	(3.9383)	(2.0862)	(3.9378)
Index riskinfo × *Covid period*	43.368***	15.993	43.23***	15.675
	(3.3193)	(10.5692)	(3.2661)	(10.3029)
Time to maturity	-2.047***	-2.063***	-1.752***	-1.544**
	(0.2318)	(0.5855)	(0.1878)	(0.656)
Post covid period			0.033***	0
			(0.008)	(0)
Own period × *Post covid period*			-0.021	-0.013
			(0.0241)	(0.0425)
Peer firm announcement × *Post covid period*			-0.019	-0.037
			(0.0197)	(0.0422)
Index riskinfo × *Post covid period*			-13.311***	-20.299**
			(3.3106)	(8.3794)
Constant	0.07***	0.017	0.06***	0.023
	(0.0092)	(0.0232)	(0.0079)	(0.0249)
Firm fixed effects	No	Yes	No	Yes
Industry year qtr fixed effects	No	Yes	No	Yes
N	18921	18921	26996	26996
R^2	0.1252	0.19542	0.10132	0.17

Note: The dependent variable in columns (1) - (2) is *Riskinfo*. In columns (1) and (2), *Covid period* is a dummy variable that takes the value 1 for all firm-day observations falling in the date range March 1, 2020 to June 20, 2020 and 0 otherwise. In columns (3) and (4), to identify the COVID-19 period and the post COVID-19 period, factor variable $Period_t$ has three levels, as in Equation 10. *Covid period* is the level 1, representing all firm-day observations in the date range March 1, 2020 to June 30, 2020. *Post covid period* is the level 2, representing all firm-days observations in the date range July 1, 2020 and September 23, 2021. All other firm days are represented by the level 0, called *Pre-covid period*. All other variables are defined in Table 1. All coefficients are in percentage. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 10: Firm risk information - COVID-19 period - estimation from 2019 to 2021

Var	*Riskinfo*			
	(1)	(2)	(3)	(4)
Own period	0.207***	0.212***	0.203***	0.207***
	(0.0282)	(0.0428)	(0.0249)	(0.0426)
Covid period	0.353***	1.128***	0.357***	1.143***
	(0.0232)	(0.123)	(0.0205)	(0.1245)
Own period × *Covid period*	-0.357***	-0.138**	-0.356***	-0.154***
	(0.0708)	(0.0536)	(0.0626)	(0.0497)
Peer firm announcement	0.092***	0.076***	0.092***	0.076***
	(0.0244)	(0.0245)	(0.0216)	(0.0252)
Peer firm announcement × *Covid period*	-0.231***	-0.104**	-0.23***	-0.097**
	(0.0564)	(0.0394)	(0.0498)	(0.0408)
Index riskinfo	35.567***	34.642***	35.638***	35.11***
	(3.2222)	(5.0269)	(2.85)	(5.0409)
Index riskinfo × *Covid period*	51.239***	23.533**	49.973***	21.669**
	(4.4938)	(11.1935)	(3.9669)	(10.8418)
Time to maturity	-3.989***	-4.262***	-2.307***	-2.013*
	(0.4901)	(1.0786)	(0.2782)	(1.0601)
Post covid period			0.06***	0
			(0.0116)	(0)
Own period × *Post covid period*			-0.005	0.001
			(0.0335)	(0.0557)
Peer firm announcement × *Post covid period*			-0.047*	-0.044
			(0.0279)	(0.046)
Index riskinfo × *Post covid period*			-7.616*	-15.518*
			(4.0084)	(9.1915)
Constant	0.116***	-0.019	0.057***	0.009
	(0.02)	(0.0416)	(0.0132)	(0.0404)
Firm fixed effects	No	Yes	No	Yes
Industry year qtr fixed effects	No	Yes	No	Yes
N	6607	6607	14682	14682
R^2	0.19046	0.29559	0.13014	0.22166

Note: The dependent variable in columns (1) - (2) is *Riskinfo*. In columns (1) and (2), *Covid period* is a dummy variable that takes the value 1 for all firm-day observations falling in the date range March 1, 2020 to June 20, 2020 and 0 otherwise. In columns (3) and (4), to identify the COVID-19 period and the post COVID-19 period, factor variable $Period_t$ has three levels, as in Equation 10. *Covid period* is the level 1, representing all firm-day observations in the date range March 1, 2020 to June 30, 2020. *Post covid period* is the level 2, representing all firm-days observations in the date range July 1, 2020 and September 23, 2021. All other firm days are represented by the level 0, called *Pre-covid period*. All other variables are defined in Table 1. All coefficients are in percentage. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 11: Firm risk information : Alternative estimation of event risk

Var	*Riskinfo two day*			
	(1)	(2)	(3)	(4)
Own period	0.214***	0.218***	0.217***	0.21***
	(0.0125)	(0.0267)	(0.0262)	(0.025)
Peer firm announcement	0.056***	0.065**	0.065**	0.055***
	(0.011)	(0.0222)	(0.0225)	(0.0192)
Time to maturity	-1.841***	-1.95**	-2.056***	-2.168***
	(0.2246)	(0.6755)	(0.5719)	(0.5143)
Index riskinfo two day			29.524***	29.095***
			(5.2451)	(3.6147)
Constant	0.055***	0.057**	0.07***	0.075***
	(0.0089)	(0.0256)	(0.0224)	(0.0198)
Firm fixed effects	No	Yes	Yes	Yes
Year quarter fixed effects	No	Yes	Yes	Yes
Industry year qtr fixed effects	No	No	No	Yes
N	16942	16942	16942	16942
R^2	0.02075	0.04445	0.05548	0.09176

Note: The dependent variable in columns (1) - (4) is *Riskinfo(2 day)*. All other variables are defined in Table 1. All coefficients are in percentage. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 12: Firm risk information - COVID-19 period - Two day risk information

Var	*Riskinfo two day*			
	(1)	(2)	(3)	(4)
Own period	0.207***	0.207***	0.207***	0.206***
	(0.0126)	(0.0243)	(0.0124)	(0.0242)
Covid period	0.341***	1.139***	0.341***	1.143***
	(0.0171)	(0.1196)	(0.0168)	(0.121)
Own period × *Covid period*	-0.353***	-0.123*	-0.353***	-0.141**
	(0.053)	(0.0629)	(0.0521)	(0.055)
Peer firm announcement	0.048***	0.051***	0.048***	0.05***
	(0.0111)	(0.0175)	(0.0109)	(0.0176)
Peer firm announcement × *Covid period*	-0.165***	-0.037	-0.164***	-0.031
	(0.0417)	(0.0227)	(0.041)	(0.0233)
Index riskinfo	37.548***	33.87***	37.518***	33.957***
	(2.221)	(3.9371)	(2.1822)	(3.9138)
Index riskinfo × *Covid period*	28.889***	6.408	28.852***	6.37
	(3.324)	(9.7611)	(3.266)	(9.6376)
Time to maturity	-2.492***	-2.715***	-2.384***	-2.301***
	(0.2241)	(0.5436)	(0.181)	(0.6433)
Post covid period			0.028***	0
			(0.0078)	(0)
Own period × *Post covid period*			0.012	0.023
			(0.0233)	(0.047)
Peer firm announcement × *Post covid period*			-0.008	-0.029
			(0.0191)	(0.0374)
Index riskinfo × *Post covid period*			-17.977***	-23.803***
			(3.286)	(6.7712)
Constant	0.086***	0.04*	0.082***	0.048**
	(0.0089)	(0.0209)	(0.0076)	(0.0234)
Firm fixed effects	No	Yes	No	Yes
Industry year qtr fixed effects	No	Yes	No	Yes
N	18921	18921	26996	26996
R^2	0.10332	0.18202	0.08492	0.16426

Note: The dependent variable in columns (1) - (2) is *Riskinfo*.In columns (1) and (2), *Covid period* is a dummy variable that takes the value 1 for all firm-day observations falling in the date range March 1, 2020 to June 20, 2020 and 0 otherwise. In columns (3) and (4), to identify the COVID-19 period and the post COVID-19 period, factor variable $Period_t$ has three levels, as in Equation 10. *Covid period* is the level 1, representing all firm-day observations in the date range March 1, 2020 to June 30, 2020. *Post covid period* is the level 2, representing all firm-days observations in the date range July 1, 2020 and September 23, 2021. All other firm days are represented by the level 0, called *Pre-covid period*. All other variables are defined in Table 1. All coefficients are in percentage. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 13: Firm risk information - Absolute value of firm risk information in normal times

Var	*AbsRiskinfo*			
	(1)	(2)	(3)	(4)
Own period	0.123***	0.12***	0.118***	0.122***
	(0.0102)	(0.0171)	(0.0162)	(0.0159)
Peer firm announcement	0.041***	0.041***	0.039***	0.033***
	(0.009)	(0.0117)	(0.0124)	(0.0115)
Time to maturity	8.145***	8.527***	8.382***	8.238***
	(0.1834)	(0.6032)	(0.5859)	(0.5195)
AbsIndex riskinfo			18.074***	17.561***
			(4.558)	(3.0169)
Constant	-0.018**	-0.031	-0.044*	-0.038*
	(0.0072)	(0.0226)	(0.0233)	(0.0203)
Firm fixed effects	No	Yes	Yes	Yes
Year quarter fixed effects	No	Yes	Yes	Yes
Industry year qtr fixed effects	No	No	No	Yes
N	16942	16942	16942	16942
R^2	0.11302	0.19176	0.19474	0.23465

Note: The dependent variable in columns (1) - (4) is *AbsRiskinfo*, which is the absolute value of *Riskinfo* and analogously *AbsIndex riskinfo* is the absolute value of *Index riskinfo*. All other variables are defined in Table 1. All coefficients are in percentage. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 14: Firm risk information - Absolute value of firm risk information in COVID-19 period

Var	*AbsRiskinfo*			
	(1)	(2)	(3)	(4)
Own period	0.114***	0.117***	0.114***	0.117***
	(0.0102)	(0.0154)	(0.0098)	(0.0155)
Covid period	0.075***	0.45***	0.075***	0.445***
	(0.0168)	(0.0774)	(0.0161)	(0.078)
Own period × *Covid period*	-0.184***	-0.146***	-0.184***	-0.163**
	(0.0433)	(0.0524)	(0.0414)	(0.0622)
Peer firm announcement	0.036***	0.033***	0.036***	0.033***
	(0.009)	(0.0105)	(0.0086)	(0.0108)
Peer firm announcement × *Covid period*	-0.147***	-0.183***	-0.147***	-0.174***
	(0.034)	(0.0432)	(0.0326)	(0.0415)
Index riskinfo	22.902***	16.798***	22.868***	16.694***
	(2.0179)	(2.6382)	(1.9292)	(2.6434)
Index riskinfo × *Covid period*	81.109***	70.259***	81.136***	70.553***
	(3.1852)	(8.9797)	(3.0461)	(8.9415)
Time to maturity	7.964***	8.183***	8.023***	8.287***
	(0.1818)	(0.5234)	(0.1436)	(0.402)
Post covid period			0.015**	0
			(0.007)	(0)
Own period × *Post covid period*			-0.038**	-0.039*
			(0.0184)	(0.0219)
Peer firm announcement × *Post covid period*			-0.011	-0.006
			(0.015)	(0.0186)
Index riskinfo × *Post covid period*			-21.259***	-16.078***
			(3.0168)	(5.3144)
Constant	-0.037***	-0.06***	-0.039***	-0.054***
	(0.0074)	(0.0202)	(0.0063)	(0.0171)
Firm fixed effects	No	Yes	No	Yes
Industry year qtr fixed effects	No	Yes	No	Yes
N	18921	18921	26996	26996
R^2	0.21783	0.318	0.20271	0.29103

Note: The dependent variable in columns (1) - (4) is *AbsRiskinfo*, which is the absolute value of *Riskinfo* and analogously *AbsIndex riskinfo* is the absolute value of *Index riskinfo*. In columns (1) and (2), *Covid period* is a dummy variable that takes the value 1 for all firm-day observations falling in the date range March 1, 2020 to June 20, 2020 and 0 otherwise. In columns (3) and (4), to identify the COVID-19 period and the post COVID-19 period, factor variable $Period_t$ has three levels, as in Equation 10. *Covid period* is the level 1, representing all firm-day observations in the date range March 1, 2020 to June 30, 2020. *Post covid period* is the level 2, representing all firm-days observations in the date range July 1, 2020 and September 23, 2021. All other firm days are represented by the level 0, called *Pre-covid period*. All other variables are defined in Table 1. All coefficients are in percentage. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.

Table 15: Firm risk information - Sub-sample analysis

Var	*Riskinfo*			
	(1)	(2)	(3)	(4)
	Panel A: Sub-samples by months within a year			
	First 6 months		*Last 6 months*	
Own period	0.234***	0.226***	0.226***	0.223***
	(0.0181)	(0.0326)	(0.0189)	(0.0324)
Peer firm announcement	0.079***	0.073***	0.063***	0.072***
	(0.0158)	(0.0194)	(0.0168)	(0.0248)
Time to maturity	-1.533***	-1.589**	-1.407***	-1.833*
	(0.3331)	(0.6847)	(0.3354)	(1.0119)
Index riskinfo		38.826***		53.774***
		(4.2766)		(7.0515)
Constant	0.017	0.039	0.06***	0.081**
	(0.0132)	(0.0262)	(0.0131)	(0.037)
N	8221	8221	8721	8721
R^2	0.02496	0.11947	0.01706	0.07877
	Panel B: Sub-samples by years			
	2016 and 2017		*2018 and 2019*	
Own period	0.241***	0.238***	0.221***	0.215***
	(0.0158)	(0.0259)	(0.0206)	(0.0332)
Peer firm announcement	0.07***	0.079***	0.07***	0.064***
	(0.0143)	(0.0236)	(0.0178)	(0.0226)
Time to maturity	-0.608**	-0.977	-2.315***	-2.504**
	(0.2717)	(0.7055)	(0.3871)	(0.9512)
Index riskinfo		45.679***		41.498***
		(7.5102)		(3.9465)
Constant	0.004	0.023	0.075***	0.101***
	(0.0107)	(0.0259)	(0.0153)	(0.0355)
N	8619	8619	8323	8323
R^2	0.02753	0.07587	0.01741	0.11942
Firm fixed effects	No	Yes	No	Yes
Year quarter fixed effects	No	Yes	No	Yes
Industry year qtr fixed effects	No	Yes	No	Yes

Note: The dependent variable in columns (1) - (4) is *Riskinfo*. All other variables are defined in Table 1. All coefficients are in percentage. ***, ** and * indicate statistical significance at the 1%, 5% and 10% levels, respectively.