Intra-industry Information Transfers:
Evidence from Changes in Implied Volatility around Earnings Announcements*

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ABSTRACT

We examine whether there is intra-industry information transfer with respect to the second moment of returns around earnings announcements. Using implied volatility from option prices as a proxy for uncertainty about firm fundamentals, we find a significantly positive association between changes in the implied volatility of the first announcer in each industry and its industry peers around the first announcer's earnings announcement, suggesting that earnings announcements help resolve uncertainty about the value of not only the announcing firm but also its industry peers. This result holds after controlling for information transfer with respect to the first moment of returns. We further find that the extent of second-moment information transfer is stronger for long-duration options, when the announcer has higher earnings quality, reports positive earnings news, or is a bellwether firm, and during periods of greater macroeconomic uncertainty. Taken together, our results suggest that there exists second-moment information transfer around earnings announcements that is incremental to its first-moment counterpart; thus, industry peers' earnings announcements represent an important disclosure that conveys timely information about industry uncertainty.

Keywords: Second-moment information transfer, implied volatility, volatility-relevant information, uncertainty, earnings announcements

1. Introduction

A large stream of research in accounting examines whether there are intra-industry information transfers around earnings announcements.[1] Much of this research focuses on the transfer of first-moment information that can lead to a revision in the market's expectation about peer firms' stock returns. Earnings announcements, however, convey information that is useful to assess not only peer firms' expected future cash flows, but also the uncertainty about their future cash flows. Yet, we know little about whether there is transfer of second-moment information around earnings announcements that can lead to a revision in the market's expectation about peer firms' return volatility. Given the large impact of uncertainty on a firm's information environment, the literature's focus on the first-moment information transfer is surprising. In this paper, we examine whether there is second-moment intra-industry information transfer by studying changes in implied volatility around earnings announcements.

On the surface, given the volume of evidence on the presence of first-moment information transfer, it might seem natural to also observe second-moment information transfer around earnings announcements. However, whether there exists a second-moment information transfer that is incremental to its first-moment counterpart is less clear ex ante. On the one hand, we should observe an incremental second-moment information transfer if an announcer's earnings news conveys information about industry uncertainty beyond that reflected in its equity returns. On the other hand, if the volatility-relevant information conveyed in earnings is largely firm-specific, we may not observe a significant second-moment information transfer. Moreover, recent research shows that information useful in predicting the first moment of returns is not necessarily useful in

[1] See Schipper (1990) for a review of earlier research on information spillovers or information transfers. More recent studies include Ramnath (2002), Thomas and Zhang (2008), Pandit, Wasley, and Zach (2011), and Brochet, Kolev, and Lerman (2017).

predicting the second moment of returns (Sridharan 2015); thus, earnings news that leads to a revision in the market's expectation about peer firms' mean returns may not affect their return volatility. Lastly, to the extent that traders in the option market have an information advantage over those in the equity market (e.g., Jin, Livnat, and Zhang 2012), they may not rely on peer firms' earnings announcements to the same extent, in which case the first-moment information transfer observed in equity returns may not extend to a second-moment information transfer in the option market. Thus, whether there exists intra-industry information transfer with respect to the second moment of stock returns that is incremental to that with respect to the first moment of stock returns around earnings announcement is ultimately an empirical question.

We address this question using a sample of 24,232 firm-quarter observations comprising 3,030 unique firms operating in 217 industries at the 4-digit SIC level over the 1996 to 2017 period. Following prior research (e.g., Rogers, Skinner, and Van Buskirk 2009; Billings, Jennings, and Lev 2015), we use implied volatility from exchange-traded option prices to capture uncertainty about firm fundamentals. Implied volatility is particularly attractive in our context because it can be measured on a daily basis and thus is ideal for short-window event analysis. Moreover, implied volatility is calculated for standardized options with durations ranging from 30 to 730 days, which allows us to examine whether the degree of information transfer, if any, varies with the nature of the information with respect to the persistence of uncertainty.[2] To examine whether there is second-moment information transfer around earnings announcements, we first identify a set of "first announcers" or "initial" announcements—the first firm to release earnings in each industry-quarter—and match these firms to industry peers that announce their earnings at least 10 trading

[2] We include implied volatility derived from options ranging from 30 to 365 days because the sample size becomes significantly smaller when we use options with longer duration (>365 days).

days after the first announcer. We then examine the association between the changes in implied volatility for the first announcer and its peers around the initial earnings release.

Before we turn to our results, it is worth noting that prior research finds on average an upward trend in implied volatility in the pre-announcement period followed by a sharp decline after the announcement, consistent with a buildup in uncertainty about firm fundamentals before the earnings release and a resolution of uncertainty after the arrival of the earnings news (Patell and Wolfson 1979, 1981; Truong, Corrado, and Chen 2012).[3] Building on this literature, we are primarily interested in whether the second-moment information that *resolves* uncertainty around earnings announcements is transferred to industry peers, that is, whether earnings news leads to a downward revision in investors' expectations about not only the future stock volatility of the announcing firm, but also that of its industry peers. However, information that increases uncertainty around earnings announcements can also be transferred to peers. Indeed, while a majority of earnings announcements resolve uncertainty, about 25% to 35% of our first announcers experience an increase in implied volatility after their earnings release.[4] Given that the nature of earnings announcements that resolve uncertainty is likely to differ from that of earnings announcements that increase uncertainty, we separately examine the extent of second-moment information transfer for first announcers with negative versus positive changes in implied volatility (hereafter, "decreasers" and "increasers") around their earnings releases.

We find that, around the first announcer's earnings announcement, its changes in implied volatility are significantly positively associated with those of its industry peers, consistent with the presence of second-moment information transfer. This result holds for both decreasers and

[3] Consistent with prior research, in untabulated results we find a similar increase in implied volatility before earnings announcements and a significant drop around earnings announcements for options with different durations, with this pattern being more pronounced for short-duration volatility.
[4] This result is consistent with that documented in Gallo (2017) and Neururer, Papadakis, and Riedl (2016).

increasers for options with varying durations, and is robust to controlling for pre-announcement volatility co-movement between the first announcer and its industry peers and the extent of first-moment information transfer, measured by the first announcer's and its industry peers' abnormal returns. We further find that the magnitude of information transfer is smaller for 30-day options. The weaker result for the 30-day options is perhaps not surprising as short-term options tend to reflect primarily firm-specific information that is more transitory in nature and hence less informative about peers. This result is consistent with the idea that we may not observe significant second-moment information transfer if the news about fundamental uncertainty is largely firm-specific. Also, the stronger result for long-duration options suggests that information about industry and market uncertainty tends to be more persistent. Taken together, the results are consistent with the presence of second-moment information transfer around earnings announcements, whereby earnings news leads to revisions in investors' anticipated uncertainty about not only the announcing firm's value, but also that of its industry peers. Moreover, the transfer of second-moment information is incremental to its first-moment counterpart, consistent with earnings releases conveying information about industry uncertainty beyond that reflected in the first moment of returns.

Although our results suggest that there is transfer of second-moment information for both first decreasers and increasers, the documented positive association for increasers may be mechanical—the increase in the first announcer's implied volatility around its earnings announcement may coincide with the general upward trend in its peer firms' implied volatility over their respective pre-announcement periods, resulting in a mechanical positive association between changes in volatility of the announcer and its peer firms that are unrelated to the transfer of second-moment information. Therefore, in subsequent analyses we focus on the first-decreaser

sample (i.e., the first announcers with earnings announcements that *resolve* uncertainty), where we can reliably draw inferences about second-moment information transfer.

To examine whether the extent of information transfer we document varies with the nature of the information conveyed in earnings announcements and the announcer's status in the industry, we perform several cross-sectional analyses. Intuitively, earnings announcements that convey more informative industry news and resolve more uncertainty for the announcing firm should induce a greater information transfer. We therefore argue that among the first decreasers, those who are industry bellwethers, report higher-quality earnings, or report positive earnings news (Truong et al. 2012; Rogers et al. 2009) tend to resolve greater uncertainty, and hence, should induce a higher degree of second-moment information transfer. Consistent with our predictions, we find that the positive association between changes in the implied volatility of the first announcer and its peer firms is significantly stronger when the announcer is larger, is an S&P 500 firm, has higher earnings quality, or reports positive earnings news. Thus, the extent to which investors rely on peers' earnings announcements to resolve uncertainty varies predictably with the nature of the news and the quality of the earnings signal. These results suggest that the documented second-moment information transfer is unlikely to be spurious, but rather stems from the earnings news of the announcer.

Given that earnings announcements represent a timely disclosure that can help resolve uncertainty about industry peers' fundamentals, we next examine whether the degree of second-moment information transfer varies with the macroeconomic environment. We predict that investor demand for information that can help resolve uncertainty should be more pronounced in times of high economic uncertainty. Consistent with this conjecture, we find that the positive association between the implied volatility of the announcing firm and that of its industry peers is

significantly stronger during recessions and in periods marked by a high level of market anxiety, suggesting that peers' earnings announcements are a particularly important source of information in times of heightened economic uncertainty.

Next, we examine whether the second-moment information transfer around earnings announcements, which we document among industry peers in the same 4-digit SIC code, is also present among peers identified by other industry definitions. Specifically, we perform our main analysis using the product-based industry classifications (FIC-400) introduced by Hoberg and Phillips (2010, 2016), and we find qualitatively similar results. Moreover, we find that the extent of information transfer is quite similar across the two sets of peers (i.e., 4-digit SIC vs. FIC-400), which suggests that the SIC-based approach is not inferior to other industry classifications in identifying the hypothesized information transfer phenomenon.

As discussed earlier, we use implied volatility as a proxy for fundamental uncertainty because it has several attractive features. We acknowledge that conceptually, implied volatility more directly reflects price volatility, which can be affected by factors other than fundamental uncertainty. To shed light on whether our main results are attributable to the fundamental uncertainty component of implied volatility, we perform an additional analysis in which we follow Gallo (2017) and use dispersion in analysts' earnings forecasts as a proxy for fundamental uncertainty. Specifically, we argue that implied volatility should capture largely the fundamental uncertainty component when changes in implied volatility and changes in forecast dispersion move in the same direction. We find that the extent of information transfer is significantly stronger for the subsample of first announcers whose changes in implied volatility and forecast dispersion around the earnings announcement move in the same direction. This result suggests that our

findings are primarily explained by the transfer of information about fundamental uncertainty around the earnings announcement.

Our paper makes several contributions to the literature. First, prior research on information transfers focuses solely on first-moment effects, that is, information transfer with respect to mean equity returns (e.g., Foster 1981; Clinch and Sinclair 1987; Han, Wild, and Ramesh 1989; Han and Wild 1990; Freeman and Tse 1992; Brochet, Kolev, and Lerman 2017). Our study complements this literature by documenting the existence of second-moment information transfers that are incremental to the transfer of first-moment information around earnings announcements. To the best of our knowledge, our study is the first to document directly the presence of second-moment information transfers. As discussed earlier, it is unclear ex ante if second-moment information transfers exist and if they are incremental to its first-moment information counterpart around earnings announcements.[5] Indeed, we find that the extent of information transfer is smaller for short-duration options when firm-specific information is likely to dominate. The variation in option durations also allows us to exploit interesting dimensions with respect to the nature of information transfers (e.g., the persistence of uncertainty) that cannot be examined with respect to first-moment information transfers. Further, analogous to early literature on first- and second-moment market reactions to earnings news (e.g., Ball and Brown 1969; Patell and Wolfson 1979, 1981), we believe that documenting the presence of second-moment information transfer around earnings announcements is interesting in and of itself as it sheds new light on the effect of

[5] In a preliminary analysis (untabulated), we separately examine first- and second-moment information transfers by industry. We find that the correlation between the degree of first- and second-moment information transfers is about 0.25, which suggests that while there is a positive association between the two types of information transfers, they are distinct. Improving our understanding of when and why the two types of information transfers diverge represents a fruitful avenue for future research.

disclosure on uncertainty about firm value, an important dimension of a firm's information environment that should not be overlooked.

Second, our study adds to the rich literature on the information content of earnings announcements. While prior research suggests that earnings announcements contain relatively little new firm-specific information (e.g., Lev 1989; Ball and Shivakumar 2008), our results show that earnings announcements convey new information that helps resolve uncertainty about industry fundamentals. These results add to the relatively sparse body of work on the effect of disclosures on uncertainty (e.g., Rogers et al. 2009; Billing et al. 2015) by highlighting the important role of peer firms' mandatory disclosure in a firm's overall information environment.

Lastly, recent research examines the effects of information transfers on peer firms' disclosure choices and investment efficiency (e.g., Beatty, Liao, and Yu 2013; Badertscher, Shroff, and White 2013; Shroff, Verdi, and Yost 2016). Our study complements this growing stream of research by showing that, by conveying information about industry uncertainty, peers' earnings announcements may represent a channel through which industry peers generate positive information externalities.

The rest of the paper is organized as follows. Section 2 reviews related literature. Section 3 describes our sample, variables, and research design. Section 4 presents our main empirical results, and Section 5 reports additional analyses and robustness tests. Finally, Section 6 concludes.

2. Related Literature

Information Transfer around Earnings Announcements

Our paper is related to the rich literature on information transfer in capital markets, especially information transfer around earnings announcements.[6] Early studies that address this question (e.g., Firth 1976; Foster 1981; Clinch and Sinclair 1987; Han et al. 1989; Han and Wild 1990; Freeman and Tse 1992) generally find evidence of information transfer as reflected in the stock prices of non-announcing peers. More recent research extends this work by examining whether the transferred information around earnings announcements is fully impounded into analysts' and investors' decisions or the mechanism that facilitates the information transfers. For instance, Ramnath (2002) finds that although analysts incorporate the information contained in early announcements when revising earnings forecasts for subsequent announcers, they tend to underreact to the news in these announcements for first announcers. In contrast, Thomas and Zhang (2008) find that investors in late announcers overreact to the information contained in early announcers' news releases, as evidenced by the predictable price movements when the late announcers subsequently report their earnings. Pandit et al. (2011) study information transfer along the supply chain and find that suppliers experience an information externality at the time of customers' earnings announcements. Brochet et al. (2017) examine the mechanism through which information flows to industry peers during earnings announcements. Using intra-day data, they find a significant return co-movement between announcing firms and their industry peers around quarterly earnings conference calls, suggesting that conference calls are an important channel of information transfer along with earnings release. Drake, Jennings, Roulstone, and Thornock (2016)

[6] Because the focus of our study is on intra-industry information transfer around earnings announcements, we provide a brief review only on the studies that are related to information transfers around earnings announcements—we do not include studies that examine information transfer in other contexts (e.g., Hamao, Masulis, and Ng 1990; King and Wadhwani 1990; Laux, Starks and Yoon 1998; Gleason, Jenkins and Johnson 2008).

find that co-movement in industry returns is partially attributable to attention co-movement around earnings announcements.[7]

A common feature of the above literature is that information transfer is captured using peer firms' mean stock price reaction, that is, the first moment of returns. A natural question that arises is: Do these first-moment information transfers extend to the second moment of returns? Conceptually, we may observe information spillovers with respect to the first (second) moment of returns around an earnings announcement if it conveys information about market returns (volatility). Given that the extent to which a firm's return covaries with market returns is distinct from the extent to which a firm's return volatility covaries with market volatility (e.g., Barth and So. 2014), first-moment spillover effects may not extend to the second moment. Consistent with this view, Sridharan (2015) shows that information that is useful in predicting the first moment of returns is not necessarily useful in predicting the second moment of returns. Whether there is significant volatility spillover around earnings announcements is thus an empirical question, which we address in this study.

Implied Volatility around Earnings Announcements

Patell and Wolfson (1979, 1981) provide a framework for thinking about how expected future volatility should behave around earnings announcements. Using implied volatility, which captures investors' expectation about a firm's future stock return volatility, they predict and find that implied volatility increases ahead of an earnings announcement, peaks shortly before the announcement, and decreases sharply after the announcement. More recent research (e.g., Isakov and Perignon 2001; Truong et al. 2012) finds a similar pattern around earnings announcements

[7] To ensure that any second-moment information transfer that we observe is not merely driven by industry co-movement in volatility, we control for pre-announcement volatility co-movement between the first announcer and its industry peer firms in our robustness test and find qualitatively similar results.

and extends this finding by studying whether this pattern varies with the information content of earnings (e.g., good news vs. bad news). Neururer et al. (2016), by comparing three types of Bayesian learning models, examine how changes in implied volatilities around earnings announcements vary with the size of the earnings signals. A key finding of their study is that large earnings surprises can trigger an increase in uncertainty, which is best explained by the Bayesian models that allow for an increase in posterior variance.

Our study extends this literature by examining whether the observed patterns of implied volatility around earnings announcements spill over to industry peers. We predict that if the earnings announcement of the first announcer contains news about industry or market uncertainty that is relevant to its industry peers, then changes in peer firms' implied volatilities around the first announcer's earnings announcement should be positively associated with those of the first announcer.

Externalities of Peer Firms

Our paper is also related to the literature that studies how a firm's disclosed information can generate externalities to peers and affect peer firms' real decisions. For instance, Beatty et al. (2013) examine the spillover effect of fraudulent reporting on peers' investments and document that peer firms react to inflated financial performance and overstated investment prospects by increasing investment during fraud periods. Durnev and Mangen (2009) find that peers significantly lower their investment growth in the year after a competitor's restatement announcement, suggesting that peers learn from the restatement and adjust their investment strategies accordingly. Badertscher et al. (2013) find that private firms are more responsive to their investment opportunities when they operate in industries with greater public firm presence. Using

a sample of private firms that raise public debt, Shroff et al. (2016) find that peer-firm disclosures lower bond yields substantially for first-time capital raisers.

In this study, we examine whether the resolution of uncertainty around earnings announcements spills over to the announcing firm's industry peers. The presence of such an intra-industry information transfer with respect to the second moment of stock returns may represent one channel through which peers' disclosure generates positive information externalities.

3. Sample, Variables, and Research Design

3.1. Sample

We obtain option data from Options Metrics Standardized Options Ivy DB, which provides the hypothetical at-the-money standardized implied volatility with varying durations from 30 to 365 days for all Chicago Board Options Exchange-listed options.[8] They calculate standardized option implied volatility using linear interpolation of traded options around the desired constant durations. Our sample period is from 1996, when the option data first become available, to 2017. We collect accounting data from the Compustat quarterly files and equity returns data from the Center for Research in Security Price (CRSP) database. We restrict our sample to firms in industries with at least five observations at the 4-digit SIC level. Consistent with prior studies (Freeman and Tse 1992; Thomas and Zhang 2008), we limit our sample to firms with December fiscal year-ends to ensure that the announcer and peer firms have the same fiscal quarter-ends. Following Barth and So (2014), we compare I/B/E/S and Compustat earnings announcement dates

[8] Although standardized options are available up to 730 days (i.e., 547 and 730 days), we include implied volatilities derived from options only up to 365 days in our analysis because the sample size becomes significantly smaller for options with durations greater than 365 days.

and assume the earlier date is correct. The final "implied volatility sample" includes 24,232 firm-quarter observations for 3,030 unique firms in 217 industries at the 4-digit SIC level.

3.2. Implied Volatility and Uncertainty

We use implied volatility based on exchange-traded option prices as an ex-ante proxy for uncertainty as it captures investors' expectations about the future stock return volatility. Due to its forward-looking characteristic, implied volatility has been commonly used as a proxy for uncertainty about a firm's prospects (Billings et al. 2015). Prior studies (Beckers 1981; Fleming 1998; Christensen and Prabhala 1998) document that implied volatility better predicts future stock return volatility than historical stock return volatility. Also, implied volatility can be measured on a daily basis, which is particularly attractive for our short-window analysis. We obtain the implied volatility of call and put options from OptionMetrics' Standardized Options dataset, which provides daily implied volatility derived from hypothetical at-the-money options. OptionMetrics calculates the interpolated implied volatility using options with various maturities and strike prices, and thus the use of the Standardized Option dataset allows us to avoid making an arbitrary decision on which strike price and maturity to employ. In our analysis, we follow prior research (e.g., Rogers et al. 2009; Truong et al. 2012; Gallo 2017; Billings et al. 2015) and calculate implied volatility, *IV*, as the average implied volatility for call and put options.[9]

To capture second-moment information in our context, we use changes in *IV* (ΔIV) to measure changes in uncertainty around the first announcer's earnings announcement. Apart from the nature of *IV* as a theoretically sound proxy for uncertainty and the fact that it is suitable for short-window analysis, another advantage of using ΔIV is that how it moves with uncertainty is clear.

[9] We also performed our main test using implied volatility based on either call or put options and obtained similar results.

An alternative measure that captures the first announcer's second-moment information is earnings surprises. While earnings surprises are more directly related to earnings by definition, using it to measure the second-moment information conveyed in earnings announcements is problematic for several reasons. First, earnings surprises contain information about both the magnitude of future cash flows (i.e., first-moment information) and the uncertainty (volatility) of future cash flows (i.e., second-moment information). To cleanly isolate the second-moment information component from earnings surprises is admittedly challenging. Also, the magnitude of earnings surprises is arguably a cleaner measure of first-moment information.

Second, it is unclear how a firm's implied volatility should move with its own earnings news. Unlike the relation between earnings surprises and changes in the first moment of stock returns (which has a clear positive relation), the relation between earnings surprises and changes in the second moment of stock returns is less clear. Evidence from prior research (e.g., Truong et al. 2012) suggests that both positive and negative surprises can resolve uncertainty, although the extent is stronger for positive news. Further, Neururer et al. (2017) show that the relation between the magnitude of earnings surprises ("signed SUE") and changes in implied volatilities around earnings announcements is not monotonic – positive earnings surprises do not always resolve implied volatilities around earnings announcements. In fact, consistent with their "*Bayesian Learnings with Increased Posterior Uncertainty*" hypothesis, extreme earnings surprises (in either direction) can trigger greater uncertainty as opposed to resolving uncertainty, resulting in a U-shape relation between signed SUE and changes in implied volatility.[10] In short, while earnings

[10] Specifically, Neururer et al. (2017) compare three models, *Constant Uncertainty Resolution, Uncertainty Resolution Conditioned on Signal Size,* and *Bayesian Learning with Increased Posterior Uncertainty*, and examine which model best explains investors' posterior variance when investors update their uncertainty at earnings announcements. The release of a new earnings signal generally decreases posterior uncertainty, which is consistent with the *Constant Uncertainty resolution* model. However, when the new earnings signal deviates greatly from expectation, it does not always lead to resolution of uncertainty around the earnings announcements. While the second model predicts that the resolution of uncertainty around the earnings announcement can be attenuated by the size of earnings surprises, the

surprises are likely to convey some information about fundamental uncertainty, there is little theoretical guidance from prior research on the extent to which they convey second-moment information or how they affect uncertainty about a firm's future cash flows around earnings announcements.[11]

3.3. Research Design

Timeline

Figure 1 summarizes the timeline of our research design. For each industry-quarter, we identify the first announcer as the first firm that announces earnings in the industry-quarter, where industries are defined at the 4-digit SIC code level. To mitigate the confounding effect of volatility news associated with peer firms' own earnings announcements, in each industry-quarter we only keep peer firms that release an earnings announcement at least 10 trading days after the first announcer's earnings announcement.

As noted earlier, we use ΔIV around the first announcer's earnings announcement to examine whether there is information transfer around the event day. To calculate ΔIV, we take the log difference between a firm's IV measured at three days before and three days after the first announcer's earnings release, i.e., $\ln\left(\frac{IV_{A+3}}{IV_{A-3}}\right)$. Note that we measure the peer firm's change of

third model predicts that extreme earnings signals can lead to a net increase in uncertainty with respect to investors' posterior variance. They find empirical evidence consistent with the third model.

[11] Another candidate for measuring the uncertainty associated with earnings news is analysts' forecast dispersion, which has been used as a proxy for fundamental uncertainty in prior research (e.g., Gallo 2017). We do not use analysts' forecast dispersion to measure uncertainty in our setting for the following reasons. First, forecast dispersion does not precisely capture the uncertainty about the earnings announcement as it is generally calculated over a relatively long window (e.g. 90 days) around the earnings release date. As a result, (the change) in analysts' forecast dispersion is likely confounded by other information that is unrelated to the earnings announcement, which can result in a relatively noisy measure of fundamental uncertainty in our context (i.e., the change in forecast dispersion does not merely capture the change in fundamental uncertainty that stems from the short-window earnings release). Second, prior studies show that analyst forecast (and thus the corresponding dispersion) can be biased because of analysts' strategic behaviors such as herding and self-selection (e.g., Hayes and Levine 2000; Clement and Tse 2005; Liu and Natarajan 2012).

implied volatility around the first announcer's earnings announcement date rather than around a peer firm's own earnings announcement. This setting allows us to examine how investors revise their expectations about a peer firm's volatility around the first announcer's earnings release.

Second-moment Information Transfer around Earnings Announcements

To examine whether there is second-moment information transfer around the first announcer's earnings announcement, we estimate the following regressions:

$$\Delta IV\_Peers_{j,k,t} = \beta_0 + \beta_1 \Delta IV\_A_{k,t} + \beta_2 X_{j,k,t} + \delta_k + \lambda_t + \varepsilon_{j,t}. \quad (1)$$

The main variable of interest is $\Delta IV\_A_{k,t}$, the log change in the first announcer's implied volatility around its earnings announcement. The dependent variable, $\Delta IV\_Peers_{j,k,t}$, is the (log change in) implied volatility of peer firm j in industry k prior to (around) the first announcer's earnings announcement. If the first announcer's earnings announcement provides useful information about peer firms' uncertainty, we expect β_1 to be positive.

The control variables included in regressions (1), captured by $X_{j,k,t}$, primarily follow Rogers et al. (2009). Specifically, we control for various characteristics of peer firms, including size (*SIZE*), measured as the natural logarithm of the market value of equity in the last quarter; leverage (*LEV*), measured as the ratio of total debts to total assets in the last quarter; and book-to-market (*B/M*), measured as the book value of equity divided by the market value of equity in the last quarter. We also control for characteristics of the first announcer's earnings, including earnings news (*SUE_A*), measured as the standardized difference between reported earnings and analysts' latest consensus forecasts of earnings, and a bad news indicator variable (*BADNEWS_A*). In addition, we control for the number of analysts following the peer firm (*LOGAF*) and the standard deviation of analyst earnings estimates for the peer firm (*DISP*). Furthermore, to account for contemporaneous market-wide events that might confound the effect of the first announcer's

earnings announcement on industry peers' volatility, we include *ΔVIX*—the change in market implied volatility as measured by the Chicago Board Options Exchange Volatility Index. Finally, to alleviate the concern that the volatility co-movement is driven by information transfer with respect to the first moment of returns, we control for market adjusted abnormal returns of both the first announcer and peers in the three trading days around the announcer's earnings announcement (*ABRET_A* and *ABRET*). Variable definitions are detailed in Appendix A. We winsorize all continuous variables at the 1% and 99% levels. Industry fixed effects (δ_k) and Quarter fixed effects (λ_t) are included to control for unobserved industry characteristics and shifts in market-wide performance over the sample, respectively. Standard errors are clustered at the 4-digit SIC industry level to correct for unspecified correlation between observations within an industry over time.[12]

4. Empirical Results

4.1. Descriptive Statistics

Distribution of Earnings Announcements

Figure 2 presents the frequency distribution of earnings announcements over the fiscal quarters. Panel A presents the earnings announcement distribution for the full sample. In general, most firms release their earnings 15 to 30 trading days after a quarter ends, with 69% of all earnings announcements made during this window. However, there is a long tail in the distribution, with 19% of the sample firms announcing earnings after day 30. Overall, firms' quarterly earnings announcements are skewed to the right over a quarter. Panel B presents the earnings announcement distribution for first announcers. The distribution shows that a large proportion of first announcers

[12] Our results are robust to clustering standard errors by both industry and quarter.

release their earnings 9 to 18 trading days after a quarter ends, with the latest ones announcing around day 40.

Descriptive Statistics

Table 1 Panel A presents descriptive statistics for the variables used in our main analyses. The main variables of interest are the changes in implied volatility of first announcers and their industry peers (*ΔIV_A* and *ΔIV_Peers*) around the first announcer's earnings announcement. We measure the main variables using options with various durations (30, 122, 182, and 365 days).[13] Consistent with evidence from prior research (Roger et al. 2009; Truong 2012), we find that the average change in implied volatility for the first announcers is negative and the magnitude of the decline is decreasing with the duration of the options—*ΔIV_A* is on average -0.106, -0.027, -0.021 and -0.014 for options with 30, 122, 182, and 365 days to expiration, respectively. The average change in implied volatility for the industry peers is also negative, with the exception of the 30-day options—*ΔIV_Peers* is on average 0.009, -0.002, -0.002 and -0.004 for options with 30, 122, 182, and 365 days, respectively. Interestingly, despite the smaller decline in the long-horizon implied volatility for the announcer, the decline in implied volatility for the peers is greater in the long-duration options, suggesting that there is greater information transfer for the long-duration options, likely due to short-horizon option prices being dominated by firm-specific news and longer-horizon options conveying a larger portion of industry news.

With respect to the control variables, our sample firms are relatively large—the average (median) *SIZE* is 7.084 (6.902), which translates into an average market capitalization of $1,193 ($994) million. The mean (median) of *ΔVIX* is -0.014 (-0.019), suggesting that on average the

[13] Although implied volatilities are derived from standardized options with durations up to 730 days (including options with 547 and 730 days), we do not go beyond the options with duration greater than 365 days because the sample size becomes significantly smaller for those options.

market's expectation of stock market volatility declines slightly around the announcers' earnings releases. Panel B of Table 1 reports the correlations among the variables used in regression analysis, with Pearson (Spearman) correlations below (above) the diagonals.[14] *ΔIV_Peers* is positively and significantly associated with *ΔIV_A*, and this positive correlation increases with the option duration. For instance, while the correlation coefficient between *ΔIV_30_Peers* and *ΔIV_30_A* is 0.174 (0.183), the correlation coefficient between *ΔIV_122_Peers* and *ΔIV_122_A* is 0.327 (0.359), and the correlation coefficient between *ΔIV_182_Peers* and *ΔIV_182_A* is 0.336 (0.380). This provides preliminary evidence consistent with the presence of second-moment information transfer around first announcers' earnings announcements, with the extent of volatility co-movement being stronger for longer-term options. Panel B also shows a strong and positive correlation between changes in peer firms' implied volatilites and changes in VIX, suggesting that peer firms' uncertainty is also affected by contemporaneous change in market uncertainty. In addition, the positive and significant correlation between the abnormal return of the first announcer and its industry peers (0.199 (0.216)) suggests the presence of a first-moment information transfer around the earnings announcement. The negative and significant correlation coefficient between peer firms' first moment (*ABRET_A*) and second moment of returns (*ΔIV_Peers)* further suggests that there is information transfer with respect to the first moment of returns. It is therefore important that we control for this first-moment effect in our multivariate regression analysis to isolate the second-moment information transfer effect.

4.2. Second-moment Information Transfer

We first present the univariate results of the second-moment information transfer graphically in Figure 3. Specifically, Figure 3 plots the trend of implied volatility for the first

[14] The sample we use to construct the correlation coefficients in Panel B of Table 1 (4,999 observations) is restricted by the availability of the 365-day options with 365 days.

announcer (the solid line) and its industry peers (the dotted line) around the first announcer's earnings announcement for 30-, 122-, 182-, and 365-day options. The magnitude of implied volatility is normalized by the level of implied volatility on event day -20, with day 0 being the earnings announcement date. Consistent with prior research (e.g., Patell and Wolfson 1981; Isakov and Perignon 2001; Truong et al. 2012), we observe a run-up in implied volatility prior to the earnings announcement and a sharp decline after the announcement for all option durations. This pattern is observed not only for the first announcers, but also for its industry peers, suggesting that the earnings news from the first announcer resolves also the uncertainty about their industry peers' fundamentals. The extent to which changes in implied volatility for the peers mirror those for the first announcers around the first announcers' earnings announcements is stronger for the long-duration options. Overall, these univariate results provide preliminary evidence on the presence of second-moment information transfer around the first announcer's earnings announcement.

Panel A of Table 2 reports multivariate results from estimating Model (1) for the full sample in Columns (1)-(4), and separately for the announcers with $\Delta IV\_A<0$ (i.e., the "IV Decreasers") in Columns (5)-(8) and the announcers with $\Delta IV\_A>0$ (i.e., the "IV Increasers"). For each subsample, we report results using implied volatility with 30-, 122-, 182-, and 365-day options. The coefficient on ΔIV_A, our main variable of interest, is positive and statistically significant in all models, which suggests that the earnings release of the first announcer conveys information about industry uncertainty that is transferred to its industry peers. The magnitude of the spillover effect is stronger for longer-duration options.[15]

[15] In a falsification test, for each industry first announcer, we randomly select another industry with a different 1-digit SIC code as a "pseudo industry" and match the firms in this pseudo industry (i.e., "pseudo peers") with the first announcer. We do not find a significant transfer of volatility-relevant information from the first announcer to its pseudo peers.

The weaker volatility co-movement for the 30-day options is consistent with short-term options conveying primarily firm-specific information that is more transitory in nature and hence not informative about peers. The extent of volatility co-movement being stronger for long-duration options also suggests that information about industry and market uncertainty tends to be more persistent. These results are consistent with the idea that we may not observe a significant second-moment information transfer if the incremental information conveyed by changes in the announcer's implied volatility is largely firm-specific.

Among the control variables, the results for two measures are worth noting. First, *ABRET*, the abnormal returns of the announcing firm's industry peers, is negative and significant in all specifications, suggesting that there is indeed information transfer with respect to the first-moment of returns. The significant and positive coefficient on *ΔIV_A* thus indicates that the second-moment co-movement effect we observe around the earnings announcement is distinct from the first-moment counterpart (i.e., co-movement in mean equity returns). Second, *ΔVIX*, the contemporaneous log change in market volatility, is positive and significant in all specification, suggesting that either the announcer's earnings news or other contemporaneous market news convey information about market-wide uncertainty that has a significant effect on peer firms' uncertainty. The significant and positive coefficient on *ΔIV_A* thus indicates that the second-moment co-movement effect stems not only from the information about market-wide uncertainty conveyed in the announcer's earnings news—the information that affects peer firms' volatility may pertain to uncertainty about industry-level fundamentals.

Lastly, although our results suggest that there is volatility co-movement for both decreasers and increasers, the documented positive association for increasers may be mechanical. The increase in the first announcer's implied volatility around its earnings announcement may coincide

with the general upward trend in its peer firms' implied volatility over their respective pre-announcement periods, resulting in a mechanical positive association between changes in volatilities of the announcer and its peer firms that are unrelated to the transfer of second-moment information. Therefore, we focus in the subsequent cross-sectional analyses on the information transfer effect for decreasers, that is, first announcers with earnings announcements that help resolve uncertainty.

4.3. Cross-sectional Analyses

To examine whether the extent of volatility co-movement we document varies with the nature of the information conveyed in earnings announcements and the announcer's status in the industry, we perform the following cross-sectional analyses. First, we investigate whether the magnitude of second-moment information transfers is associated with the nature of the news conveyed by the first announcer's earnings announcements. We focus on two dimensions of the first announcer's earnings attributes—the quality of its earnings and the sign of its earnings surprise. Second, we test whether the documented volatility co-movement is stronger when the announcer is an industry bellwether, which is proxied by the announcer's firm size and S&P 500 membership. Since the degree of volatility co-movement is stronger for the long-term implied volatility, we focus our cross-sectional analyses on the 122- and 182-day options, using a fixed sample of firms with both sets of options available.[16]

4.3.1. Earnings Quality

If the association between the change in implied volatility of the first announcer and those of the peers arise from information transfers due to the earnings news of the first announcer rather

[16] We do not include implied volatility from the 365-day options in our cross-sectional tests because the sample size for 365-day options is significantly smaller. Our results from the cross-sectional analyses are robust to using 365-day options.

than simply volatility co-movement, we should observe cross-sectional variation in the degree of the volatility co-movement conditional on characteristics of the announcer's earnings. Prior research finds that high-quality earnings reduce frictions due to information asymmetry (e.g., Jayaraman 2008; Biddle et al. 2009; Bhattacharya, Ecker, Olsson and Schipper. 2012). Further, Badertscher et al. (2013) find that a greater public firm presence in an industry can increase private firms' responsiveness to investment opportunities, and that such an effect is stronger in industries with better information quality. Building on these findings, we predict that high-quality earnings should convey more informative news about industry uncertainty, and hence, the information transfer effect should be stronger for announcers with higher earnings quality.

To test this conjecture, we measure the first announcers' earnings quality using accruals quality based on the cross-sectional DD model (Dechow and Dichev 2002), augmented by the fundamental variables in the Jones (1991) model as suggested by McNichols (2002). Specifically, we estimate the following model for each 2-digit SIC industry with at least 10 observations in a given year:

$$TCA_{i,t} = \beta_0 + \beta_1 CFO_{i,t-1} + \beta_2 CFO_{i,t} + \beta_3 CFO_{i,t+1} + \beta_4(\Delta Rev_{i,t} - \Delta AR_{i,t}) + \beta_5 PPE_{i,t} + \nu_{i,t},$$

where *i* indexes firms. $TCA_{i,t}$ (total current accruals) is equal to ($IBEX_{i,t} - CFO_{i,t}$ -$DEPN_{i,t}$). $IBEX$ is net income before extraordinary items. $CFO_{i,t}$ is cash flow from operations. $\Delta Rev_{i,t}$ and $\Delta AR_{i,t}$ are firm *i*'s change in revenues and change in accounts receivable, respectively, while $PPE_{i,t}$ is firm *i*'s gross PPE in year *t*.[17] All variables are scaled by lagged assets. We calculate firm-level accruals quality as the standard deviation of the residuals from the DD model over years *t-4* to *t*.

[17] Following Li, Rajgopal, and Venkatachalam (2014), we adjust the change in revenues for the change in receivables based on the reasoning that it is easier to manage earnings by exercising discretion over the recognition of revenue on credit sales than on cash sales (Dechow et al. 1995).

We multiply the firm-level accruals quality values by negative one so that they are increasing in earnings quality.

We define an announcer as having high (low) earnings quality if its accruals quality is above (below) the quarterly median. We then re-run our baseline regression (Model 1) separately for the first announcers with high earnings quality ("High EQ Announcers") and low earnings quality ("Low EQ Announcers"). Table 3 reports the regression results. Columns (1) and (3) show results for 122-day options and Columns (2) and (4) present results for 182-day options. For both the 122- and 182-day options, we find that the volatility co-movement holds only for the announcers with high earnings quality. For example, in Column (1) the coefficient on ΔIV_Peers is positive and significant, while that in Column (3) it is negative and insignificant. This result is consistent with our prediction that higher-quality earnings plays a more important role in updating investors' expectation on uncertainty about peer firms' value. In addition, the finding that the degree of co-movement effect varies predictably with the announcer's earnings quality suggests that the observed volatility co-movement is associated with information transfer from the underlying earnings news information.[18]

4.3.2. Good News vs. Bad News

Next, we examine whether the extent of volatility co-movement varies with whether the announcer reports positive versus negative earnings surprises. Prior research on "volatility feedback" predicts that volatility increases more following bad news than good news (Black 1976; Campbell and Hentschel 1992). Put differently, good news is more likely to trigger a decrease in volatility around earnings announcements. Consistent with this conjecture, Truong et al. (2012)

[18] We also perform a robustness test controlling for pre-announcement volatility co-movement between the implied volatilities of the first announcer and those of its industry peers and our results (the presence of second-moment information transfer around the announcer's earnings announcement) continue to hold.

find that positive earnings surprises produce a larger uncertainty resolution than negative earnings surprises. As we note earlier, we focus on the first announcers who are decreasers, i.e., first announcers with a decrease in implied volatility around their earnings announcements. Hence, among the first decreasers, i.e., among the initial earnings announcements that resolve uncertainty, we expect to see a higher degree of information transfer when the first announcer's earnings news triggers a greater resolution of uncertainty around its earnings announcement. Given the evidence that good news (i.e., positive earnings surprises) is more likely than bad news to resolve uncertainty around earnings announcements, we predict that the observed volatility co-movement should be stronger when the first announcer reports positive earnings news. We test this prediction by estimating Model (1) separately for industry-quarters where the announcer reports positive earnings surprises ("Good News Announcers") and negative earnings surprises ("Bad News Announcers"). Table 4 presents the regression results. We find a positive and significant association between ΔIV_A on ΔIV_Peers only for the "good news" announcers. The volatility co-movement for the good news announcers is significantly greater than that for the bad news announcers, consistent with positive earnings surprises conveying more informative news than negative earnings surprises, which can resolve the uncertainty about peer firms' fundamentals.

4.3.3. Industry Bellwether

We then test whether the observed volatility co-movement is driven primarily by the announcers who are industry bellwethers. Industry news is generally impounded more quickly into the equity or option prices of bellwether firms, and hence, industry bellwethers may attract greater attention from peer firms' investors. Combined with their economic influence, the earnings announcement of bellwether firms may generate a greater information transfer. To test this prediction, we perform our main analysis by dividing the first announcers into two subsamples

based on their S&P 500 membership as well as firm size. We then re-run our baseline regression (Model 1) separately for: (1) the "S&P 500 Announcers" and "Non-S&P 500 Announcers"; and (2) the "Large Announcers" with firm size above the quarterly median and the "Small Announcers" with firm size below the quarterly median.

The results are reported in Panels A and B of Table 5, respectively. Panel A shows a significant second-moment information transfer for the S&P 500 announcers—while the coefficients of ΔIV_A for the S&P 500 announcers are positive and significant (0.129 and 0.123 for the 122-and 182-day options, respectively), the coefficients of ΔIV_A for the Non-S&P 500 announcers are insignificant (0.029 and -0.020 for the 122-and 182-day options, respectively). Panel B shows a very similar pattern. The coefficient of ΔIV_A is positive and significant only for the larger first announcers. Overall, these results, consistent with our prediction, show that the extent of second-moment information transfer with regard to uncertainty is stronger when the announcer is an industry bellwether.

4.4. Second-moment Information Transfer: Macroeconomic Uncertainty

Given that earnings announcements represent a timely disclosure that can help resolve uncertainty about industry peers' fundamentals, we next examine whether the degree of volatility co-movement varies with the macroeconomic environment. When there is a high level of macroeconomic uncertainty, investors face more difficulty predicting firms' future performance (Pandit et al. 2011). Investors are likely to place more weight on the information contained in early announcers' earnings because it represents a useful information signal about peer firms' fundamentals. Hence, we predict that investor demand for information that can help resolve uncertainty, and thus the extent of volatility co-movement, should be more pronounced in times of high economic uncertainty. To test our conjecture, we estimate the following equation:

$$\Delta IV\_Peer_{j,k,t} = \beta_0 + \beta_1 \Delta IV\_A_{k,t} + \beta_2 \Delta IV\_A_{k,t} * UNCERTAIN_t + \beta_3 UNCERTAIN_t + \delta_k + \lambda_t + \varepsilon_{j,t}, \quad (2)$$

where *UNCERTAIN* is the level of macroeconomic uncertainty prevailing at the time of first announcers' earnings releases, which is captured by two measures: (1) a dummy variable that indicates recessions based on NBER's Business Cycle Expansions and Contractions definition (*RECESSION),* and (2) the anxious index that reflects professional forecasters' estimation on the probability of a decline in real GDP.[19] Recessions during our sample period include the four quarters of 2001 and the period starting from the fourth quarter of 2007 to the second quarter of 2009. To account for non-linearity, we use the quartile rank of the anxious index. All other variables are defined previously and detailed in the Appendix. We predict that β_2 is positive.

Panels A and B of Table 6 present the regression results of estimating Model (2). Using both measures of macroeconomic uncertainty, the coefficients of the interaction term (i.e., *ΔIV_A*RECESSION* in Panel A and *ΔIV_A*ANXIOUS* in Panel B) are positive and statistically significant. Overall, consistent with our conjecture, the positive association between the announcing firm's and its industry peers' implied volatility is significantly stronger during recessions and in periods characterized by a high level of market anxiety, suggesting that peers' earnings announcements are a particularly important disclosure in the presence of heightened economic uncertainty.

5. Additional Analyses and Robustness Tests

In this section, we discuss several additional analyses that provide corroborating evidence for our main findings. We first investigate whether the documented second-moment information

[19] NBER Business Cycle Expansions and Contractions definition is from http://www.nber.org/cycles.html. The anxious index is taken from the following link: https://www.philadelphiafed.org/research-and-data/real-time-center/survey-of-professional-forecasters/anxious-index.

transfer effect is also present among peers identified by other industry classifications and evaluate whether the SIC-based approach is inferior to other industry classifications in identifying the hypothesized information transfer phenomenon. We then examine whether our main results are driven by the fundamental uncertainty component of implied volatility. Finally, we discuss a battery of (untabulated) robustness tests.

5.1 Alternative Industry Classification

Results from our main analysis suggest the presence of information transfer about uncertainty within industry peers in the same 4-digit SIC code. An interesting question that arises is whether the second-moment information from earnings announcements is more relevant for certain types of peers. For example, do information transfers also occur among peers in the same product market, and if so, is such information transfer stronger than that among peers in the same SIC industry? To explore this question, we conduct two additional tests. First, we perform our main analysis using the product-based industry classifications introduced by Hoberg and Phillips (2010, 2016). Because our analysis requires clusters of firms into certain industry groups, we rely on the fixed industry classifications (FIC), which is a transitive classification. Specifically, we use FIC-400 in the analysis, which is most comparable to the 4-digit SIC code. The results, reported in Panel A of Table 7, are qualitatively similar to our baseline results reported in Table 2.

Second, to assess whether the SIC-based industry classification is "superior" (or "inferior") to Hoberg and Phillips's product-based classification in our context, we first identify a subset of first announcers that are first announcers based on both 4-digit SIC code and FIC-400 in each quarter. We then perform the baseline tests separately on a set of industry peers based on 4-digit SIC code and FIC-400. The results are reported in Panel B of Table 7. We find that the extent of information transfer is quite similar across the two sets of peers. If anything, the results for 188-

day options are weaker for the FIC-400 peers. While these findings do not suggest that the SIC-based approach is superior in our context, the SIC-based approach is not inferior to the other industry classification in identifying the information transfer phenomenon.

5.2. Uncertainty about Fundamentals versus Uncertainty about Price

As in other short-window event studies, we use implied volatility as an empirical proxy for fundamental uncertainty. Conceptually, implied volatility likely better reflects price volatility than fundamental volatility and price volatility can be affected by factors other than fundamental uncertainty. Therefore, we perform an additional analysis to examine whether our main results are driven by the fundamental volatility component of implied volatility. Specifically, we follow Gallo (2017) and use dispersion in analysts' earnings forecasts, defined as the standard deviation of analyst individual forecasts of next quarter's earnings around the current-quarter earnings announcement, to proxy for fundamental uncertainty. We argue that implied volatility should capture a greater degree of fundamental uncertainty when changes in implied volatility and changes in forecast dispersion around the earnings announcement go in the same direction.[20] [21]

We repeat our main analysis separately for two subsamples: (1) a subsample of first announcers where implied volatility and analyst forecast dispersion both decrease around the initial earnings announcement (i.e., "same subsample"), and (2) a subsample of first announcers where implied volatility and analyst forecast dispersion change in the opposite direction around the initial earnings announcement (i.e., "opposite subsample"). If our finding is driven primarily

[20] Changes in forecast dispersion is defined as the change in the standard deviation of analyst individual forecasts of next quarter earnings around the announcement of current quarter earnings. Specifically, pre-announcement dispersion is calculated using forecasts of quarter t+1 earnings made within 90 days of the announcement date of quarter t earnings. If multiple forecasts are made by a single analyst, only the most recent is used. The post-announcement dispersion is calculated using forecasts made in the 30 days following the earnings announcement date. If an analyst has a qualifying pre-announcement forecast and does not revise it, it is carried forward to the post-period.

[21] Similar to Gallo (2017), we find in untabulated analysis that about 60% of our sample firms that experience a decrease in implied volatilities also experience a decrease in analysts' earnings forecast dispersion.

by the transfer of information about fundamental uncertainty, the extent of information transfer should be stronger for the "same subsample". Consistent with our conjecture, we find in Table 8 that the coefficient on ΔIV_A is significantly more positive in the "same subsample" than in the "opposite subsample", which suggests that our findings are at least partially explained by the transfer of information about fundamental uncertainty around the earnings announcement.

5.3. Robustness Tests

We perform several robustness tests (untabulated). First, to ensure that our main result, the presence of a second-moment information transfer around earnings announcements, is not driven by general industry co-movement pattern, we repeat our analysis controlling for the pre-announcement volatility co-movement. Specifically, similar to Brochet et al. (2017), we measure historical co-movement as the co-movement between the implied volatility of the first announcer and that of its industry peers over a 10-week window (from -50 through -11 trading days) starting 10 days before the initial earnings announcement.[22] Our results continue to hold after controlling for pre-announcement volatility co-movement. Second, we perform a robustness test to check whether the stronger second-moment information transfer for longer duration options is driven by the different sample across options with different durations. Specifically, because long-term options are not as actively traded as short-term options, the number of observations is significantly smaller for longer duration options. We therefore repeat the same analysis limiting our sample to have 365-day option data available for all options durations and we continue to find a stronger volatility co-movement for longer duration options with this constant sample, suggesting that our results are not driven by sample differences. Third, our cross-sectional tests are currently

[22] We do not include pre-announcement volatility co-movement as a control variable in our main analysis because the measure poses stringent restrictions on the data, which significantly reduces our sample size. We therefore opted to report this finding as a robustness test.

performed on a constant sample with both 122- and 182-day options available. We conduct the same set of cross-sectional analyses using an unrestricted sample and find qualitatively similar results. We also perform the same set of cross-sectional tests using 365-day options (with a smaller sample) and also find qualitatively similar results.

Lastly, to ensure that our results are not driven by measurement errors in Black-Scholes (B-S) implied volatility, we repeat our main analysis using model-free implied volatility. In the current analysis, we use implied volatility extracted from OptionMetrics Standardized Options that are based on the Black-Scholes model, which assumes that stock prices follow a specific functional form (i.e., a geometric Brownian motion) and incorporates information only from at-the-money options. However, prior research finds that the stock prices of the underlying assets do not always follow the Brownian price process and documents price jumps in the evolution of asset prices. Model-free implied volatility (MFIV) is an alternative approach that addresses these issues. To check whether our results are driven by potential measurement errors due to the specific functional form (or B-S Model) used in the estimation process, we re-estimate implied volatility based on model-free estimation following Sridharan (2015) and repeat our baseline analysis using MFIV.[23] The results using MFIV (untabulated) are qualitatively similar.

6. Conclusion

Uncertainty about fundamentals plays an important role in a firm's information environment, which has important implications for investors' and managers' decisions. Despite the large literature on first-moment intra-industry information transfers, we know little about whether there is second-moment information transfer around earnings announcements. In this

[23] We provide a more detailed discussion on the construction of MFIV in Appendix B.

study we fill this void in the literature by examining whether there exists second-moment information transfer around earnings announcements that can help resolve uncertainty about peer firms' fundamentals, and if so, how the nature of the information conveyed in earnings announcements affects this information transfer.

Using implied volatility from option prices as a proxy for uncertainty, we document a significant second-moment information transfer. In particular, the association between changes in the implied volatilities of the first announcer in each industry and its industry peers around the announcer's earnings announcement is significantly positive. This effect is stronger for long-duration options, when the announcer has higher earnings quality, reports positive earnings news, or is a bellwether firm, and during periods with greater macroeconomic uncertainty. These results suggest that earnings announcements convey information that helps resolve uncertainty about the value of not only the announcing firm, but also its industry peers. We further find that the extent of information transfer varies predictably with the nature of the news and the quality of the earnings signal, which suggests that the transfer of volatility-relevant information stems from the announcer's earnings news. Importantly, these results hold after controlling for information transfer with respect to the first moment of returns; hence, the second-moment information transfer effect we observe around earnings announcements is distinct from the first-moment information transfer. Taken together, our findings suggest that peer firms' earnings announcements are an important disclosure that reduce uncertainty about industry fundamentals.

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Appendix A: Variable Definition[24]

Variable	Definition
Variables for Information Transfer Test	
ΔIV_A	Log change in implied volatility of the first announcer within an industry-quarter around its quarterly earnings announcement, where we compare the implied volatility of the first announcer for the three-trading days before its earnings release to the three-trading days after its earnings release. Industry is defined as the 4-digit SIC code.
ΔIV_Peers	Log change in implied volatility of industry peers from three-trading days before to three-trading days after the quarterly earnings announcement of the first announcer. Industry is defined as the 4-digit SIC code.
SIZE	Natural logarithm of the market value of equity of peer firms in the last quarter.
LEV	The ratio of total debts to total assets of peer firms in the last quarter.
B/M	The book value of equity divided by the market value of equity of peer in the last quarter .
ΔVIX	The log change in *VIX* from three-days before to three-days after the first announcer's earnings announcement date.
BADNEWS_A	An indicator variable that has value of one if the first announcer experiences negative earnings news relative to consensus analysts forecast.
SUE_A	The standardized difference between the first announcer's reported earnings and expected earnings, where expected earnings is analysts' latest consensus forecasts of earnings.
LOGAF	Natural logarithm of the number of analysts with earnings estimates.
DISP	The standard deviation of analyst estimates for the peer firms.
ABRET_A	Market adjusted abnormal return of the first announcer three trading days around the announcer's earnings announcement during [-1,+1] period.
ABRET	Market adjusted abnormal return of peer firms three trading days around the announcer's earnings announcement during [-1,+1] period.
Variables for Cross-sectional Tests and Additional Analyses	
EQ	The standard deviation of the residuals from year *t-4* to year *t* of the modified Dechow and Dichev model and multiplied by negative one. The model is a regression of working capital accruals on lagged, current, and future cash flows plus the change in revenues adjusted by the change in accounts receivables and PPE. All variables are scaled by lagged total assets. The model is estimated cross-sectionally for each 2-digit SIC industry with at least 10 observations in a given year.
RECESSION	A dummy variable that indicates recessions based on NBER's Business Cycle Expansions and Contractions definition.
ANXIOUS	The quartile rank of the anxious index, which reflects professional forecasters' estimation on the probability of a decline in real GDP.

[24] All continuous variables are winsorized at the 1% and 99% level.

Appendix B: Model-Free Implied Volatility

As we discuss in Section 5.3, to ensure that our results are not driven by measurement errors arising from the use of a specific option-pricing model, we calculate model-free implied volatility (MFIV), an alternative approach to estimate implied volatility. The model-free approach does not impose any functional form on the option pricing models and incorporates information from both at-the-money and out-of-the-money options (Jiang and Tian 2005, Neururer et al. 2016). Britten-Jones and Neuberger (2000) derive model-free implied volatility based on the following formula:

$$V_{MFIV} = \frac{2e^{rT}}{T}\left[\int_0^{F_T} \frac{P(T,K)}{K^2}dK + \int_{F_T}^{\infty} \frac{C(T,K)}{K^2}dK\right], \qquad (A1)$$

where r is risk-free rate T is time to maturity, K is the strike price, C(T,K) is the value of a call option, P(T,K) is the value of a put option, and F is the forward price of the underlying assets. The derivation of equation (A1) is described in detail in Britten-Jones and Neuberger (2000) and Sridharan (2015).

Although the Britten-Jones and Neuberger model incorporates the information from a range of strike prices, applying an integral of option prices over an infinite range of strike prices is not empirically feasible. To overcome this implementation issue, we calculate model-free implied volatility using the following equation, following Sridharan (2015) and Jiang and Tian (2005):

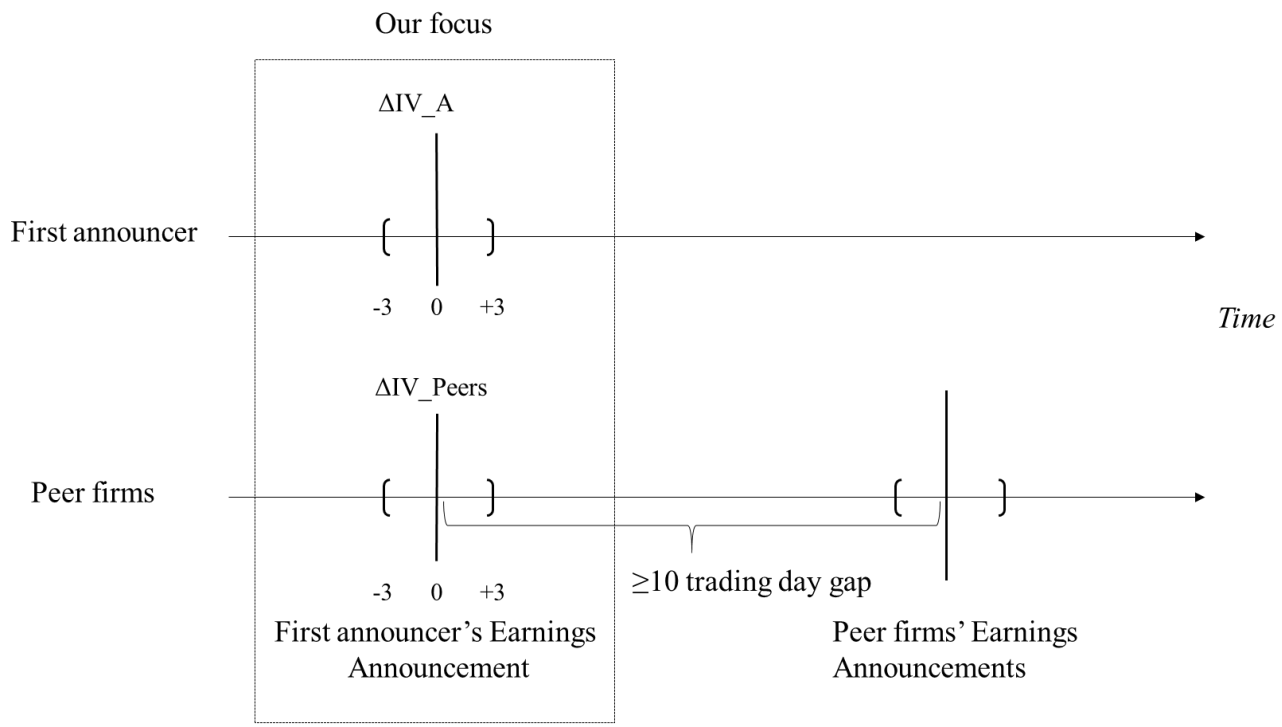
$$V_{MFIV} = \frac{2e^{rT}}{T}\left[\sum_{i=1}^{s} \frac{\Delta K_i}{{K_i}^2} P_T(K_i) + \sum_{i=1}^{M} \frac{\Delta K_i}{{K_i}^2} C_T(K_i)\right], \qquad (A2)$$

where $\Delta K_i = K_i - K_{i-1}$.

To calculate MFIV, we first extract B-S implied volatilities and strike prices for options with fixed maturities of 30, 122, 182 and 365 (calendar) days from OptionMetrics volatility surface. Next, we exclude in-the-money options, which are known to be more expensive and less liquid than at-the-money or out-of-the-money options (Jiang and Tian 2005). Finally, we calculate MFIV by applying Equation (A2) with the range of option prices. Following prior research, we require a minimum of five traded options for each firm-date (two in-the-money options, two out-of-the-money options and one at-the-money option). Finally, we exclude options that violate the basic arbitrage conditions (i.e., the bid price must be positive and less than the ask price).

Figure 1. Event Timeline

The figure describes the timeline of our research design. For each industry quarter, we identify the first firm to release earnings (the "first announcer") and then match it to a sample of industry peers that announce their earnings at least 10 trading days after the first industry announcer. We calculate the first announcer's changes in implied volatility (ΔIV) around its earnings announcement as the log ratio of the implied volatility of the three-trading days following the announcement to the implied volatility of the three-trading days prior to the announcement. We measure the peer firms' changes in implied volatility in a similar fashion around the first announcer's earnings announcement, not at the peer firms' own earnings announcement.

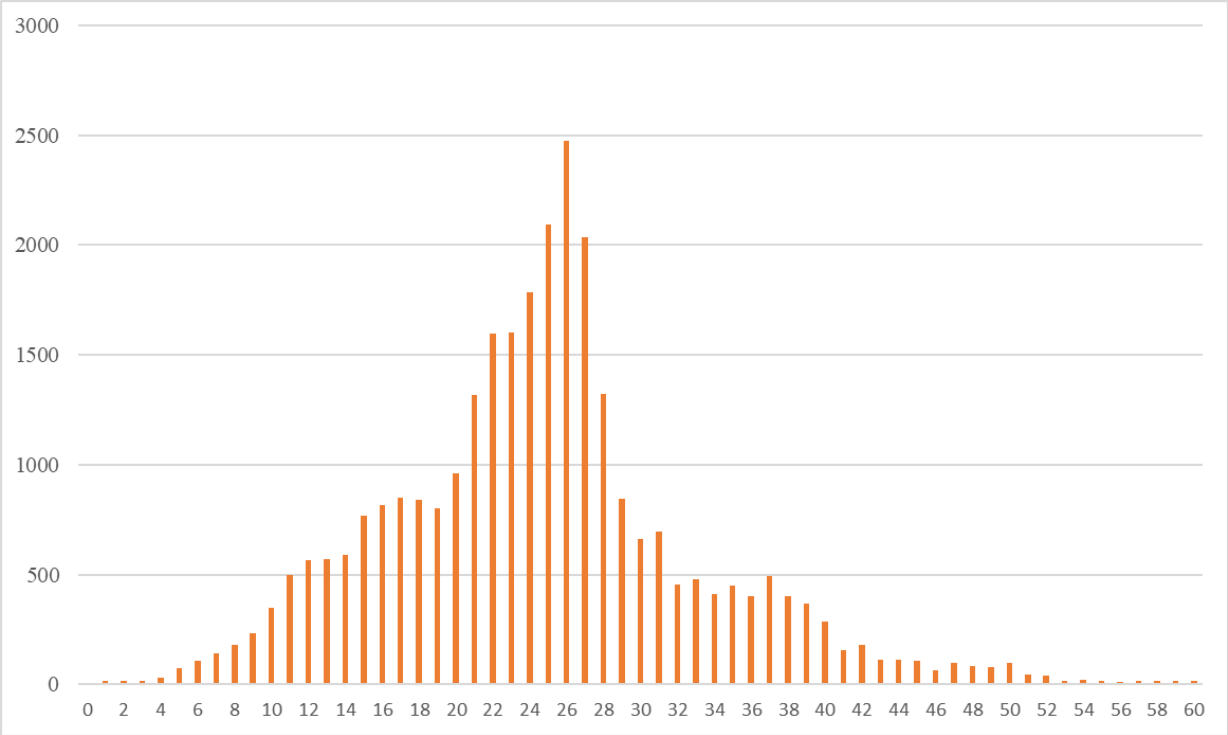


$$\Delta IV\_A \text{ or } \Delta IV\_Peers = \ln\left(\frac{IV_{EA+3}}{IV_{EA-3}}\right)$$

Figure 2. Distribution of Earnings Announcements

Figure 2 plots the frequency distribution of earnings announcement over the fiscal quarters. Panel A shows the distribution of earnings announcement for the full sample. Panel B presents the distribution of earnings announcements for the first announcing firms for each industry-quarter.

Panel A. Full sample



Panel B. First Announcer

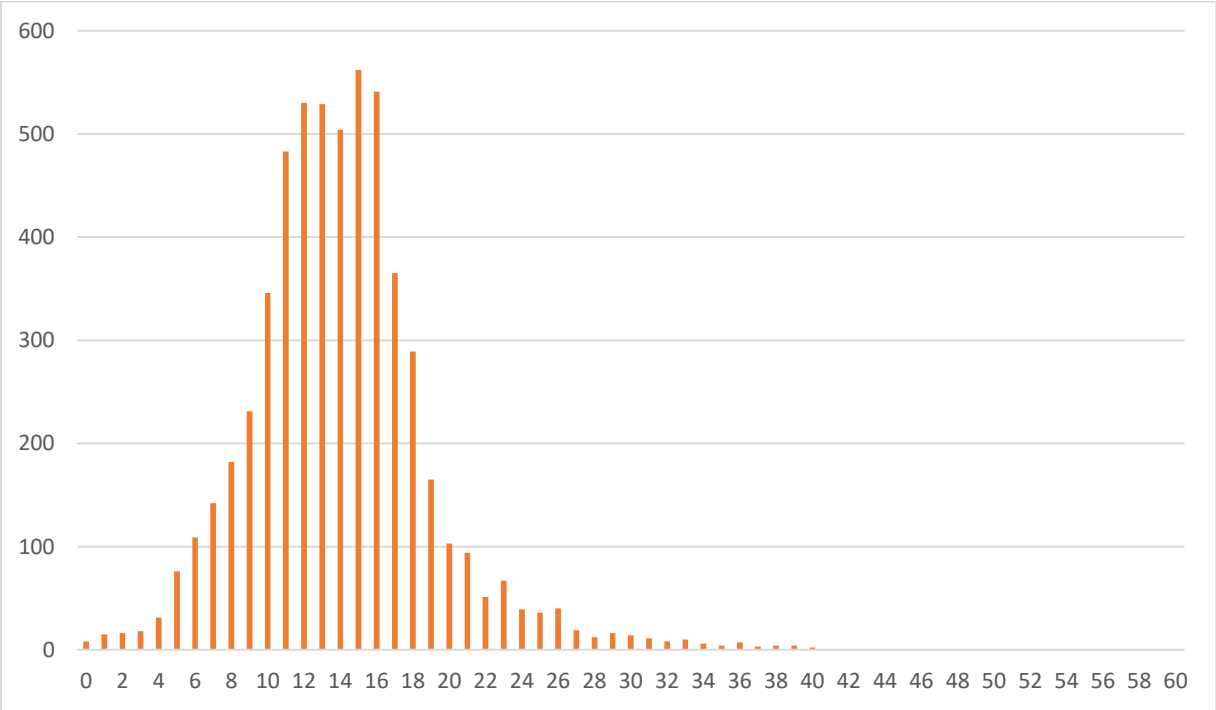
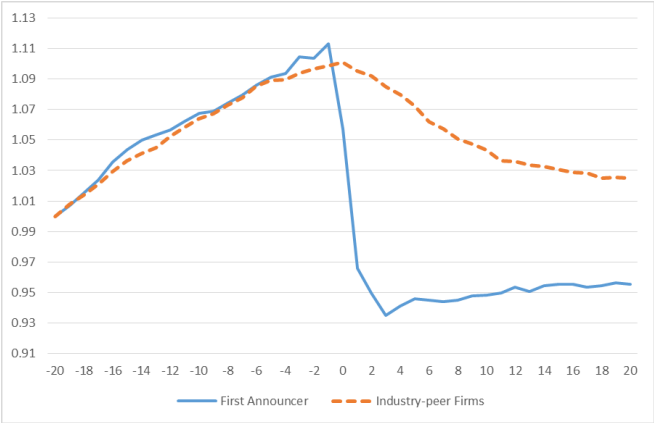


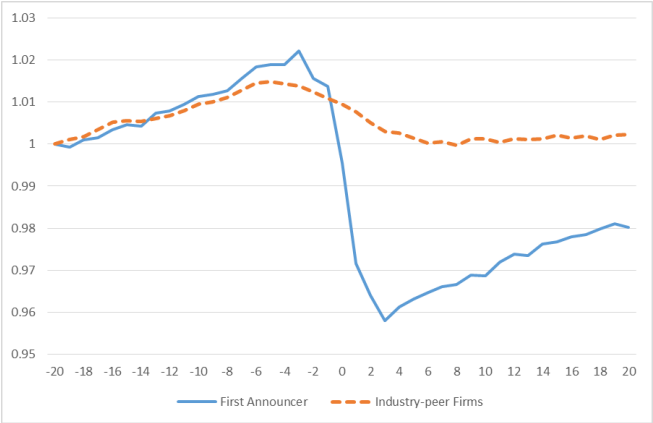
Figure 3. Second-moment Information Transfer: Changes in Implied Volatilities for the First Announcer and its Industry-peer Firms

Figure 3 plots the trend of implied volatilities around the first announcer's earnings announcements (with the announcement date being event day 0) for options with the following durations: 30, 122, 182, and 365 days. The magnitude of implied volatilities is normalized by the level of implied volatilities on event day -20. The solid line presents the implied volatilities of first announcer and the dashed lines show the implied volatilities for the announcer's industry peers.

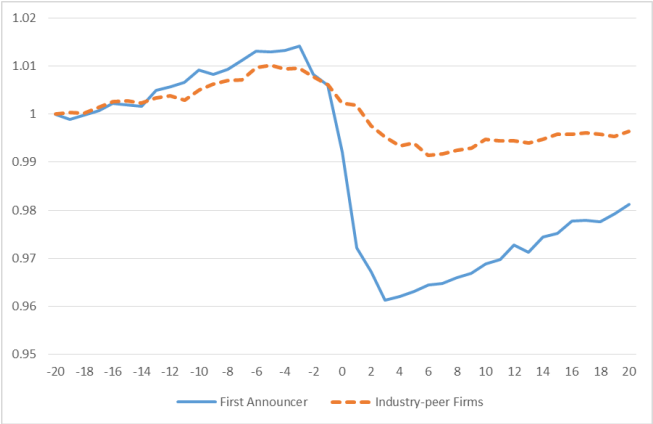
Implied volatilities with 30-day options



Implied volatilities with 122-day options



Implied volatilities with 182-day options



Implied volatilities with 365-day options

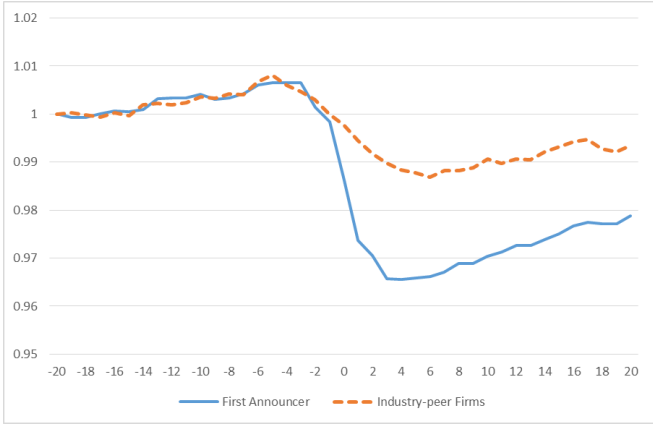


Table 1. Descriptive Statistics

This table contains descriptive statistics for the variables used in our second-moment information transfer analyses. Panel A presents descriptive statistics for the main variables. The sample includes the first announcers and their industry peers around the first announcers' earnings announcements. Panel B reports Pearson (Spearman) correlations between the variables used in our main regression analyses in the lower (upper) diagonal of the panel. Correlations in bold are significant at the 5% or 1% level. All variables are defined in Appendix A.

Panel A. Descriptive Statistics

Variable	N	Mean	Std. Dev.	P25	P50	P75
Main Variables						
ΔIV_30_A	5708	-0.106	0.150	-0.469	-0.201	-0.099
ΔIV_30_Peers	24232	0.009	0.118	-0.469	-0.050	0.005
ΔIV_122_A	5690	-0.027	0.074	-0.250	-0.071	-0.027
ΔIV_122_Peers	24034	-0.002	0.070	-0.250	-0.036	-0.004
ΔIV_182_A	3957	-0.021	0.065	-0.217	-0.058	-0.021
ΔIV_182_Peers	12778	-0.002	0.060	-0.217	-0.032	-0.004
ΔIV_365_A	2396	-0.014	0.049	-0.148	-0.046	-0.015
ΔIV_365_Peers	4999	-0.004	0.048	-0.148	-0.030	-0.004
Control Variables						
SIZE	24232	7.084	1.468	6.032	6.902	7.978
LEV	24232	0.240	0.231	0.014	0.199	0.383
B/M	24232	0.447	0.424	0.184	0.346	0.596
ΔVIX	24232	-0.014	0.136	-0.100	-0.019	0.059
BADNEWS_A	24232	0.229	0.420	0.000	0.000	0.000
SUE_A	24232	0.000	0.009	0.000	0.001	0.001
LOGAF	24232	1.685	0.703	1.099	1.609	2.197
DISP	24232	0.054	0.076	0.013	0.028	0.061
ABRET_A	24232	0.006	0.082	-0.040	0.000	0.047
ABRET	24232	0.000	0.076	-0.040	-0.003	0.035

Table 1 continued

Panel B. Correlations

	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
(1)ΔIV_30_A	**0.183**	**0.773**	**0.238**	**0.706**	**0.255**	**0.548**	**0.221**	**0.028**	**0.134**	0.011	**0.375**	**0.139**	**-0.117**	**0.030**	**0.042**	**-0.143**	**-0.064**
(2)ΔIV_30_Peers	1.000	**0.281**	**0.686**	**0.278**	**0.628**	**0.265**	**0.488**	-0.023	-0.014	**-0.068**	**0.329**	**-0.038**	0.022	-0.021	**-0.071**	**-0.062**	**-0.161**
(3)ΔIV_122_A	**0.256**	1.000	**0.359**	**0.946**	**0.372**	**0.782**	**0.325**	-0.003	**0.070**	-0.023	**0.515**	**0.113**	**-0.091**	-0.011	0.000	**-0.231**	**-0.101**
(4)ΔIV_122_Peers	**0.705**	**0.327**	1.000	**0.360**	**0.913**	**0.331**	**0.690**	**-0.047**	-0.027	**-0.058**	**0.373**	**-0.032**	0.017	**-0.035**	**-0.076**	**-0.065**	**-0.244**
(5)ΔIV_182_A	**0.249**	**0.951**	**0.323**	1.000	**0.380**	**0.832**	**0.338**	**-0.031**	**0.046**	**-0.029**	**0.538**	**0.125**	**-0.106**	**-0.029**	-0.009	**-0.251**	**-0.096**
(6)ΔIV_182_Peers	**0.637**	**0.334**	**0.908**	**0.336**	1.000	**0.348**	**0.733**	**-0.041**	-0.021	**-0.067**	**0.370**	**-0.032**	0.007	**-0.050**	**-0.072**	**-0.067**	**-0.251**
(7)ΔIV_365_A	**0.248**	**0.769**	**0.303**	**0.819**	**0.311**	1.000	**0.311**	-0.012	**0.053**	-0.021	**0.481**	**0.084**	**-0.101**	-0.011	-0.024	**-0.268**	**-0.080**
(8)ΔIV_365_Peers	**0.466**	**0.290**	**0.668**	**0.298**	**0.716**	**0.276**	1.000	**-0.037**	-0.010	**-0.068**	**0.307**	-0.026	0.002	**-0.046**	**-0.049**	**-0.069**	**-0.272**
(9)SIZE	-0.019	0.001	**-0.039**	-0.025	**-0.030**	-0.004	-0.017	1.000	**0.074**	-0.001	**-0.034**	**0.049**	**-0.081**	**0.375**	**0.083**	-0.005	**0.051**
(10)LEV	0.003	**0.054**	-0.017	**0.045**	-0.007	**0.041**	0.005	-0.021	1.000	**-0.077**	0.016	**0.080**	**-0.061**	**0.103**	**0.161**	-0.022	-0.015
(11)B/M	-0.007	-0.020	-0.015	-0.026	-0.014	-0.024	-0.006	0.009	-0.027	1.000	-0.001	**0.131**	-0.001	**0.160**	**0.070**	**0.047**	0.017
(12)ΔVIX	**0.306**	**0.483**	**0.332**	**0.506**	**0.329**	**0.449**	**0.272**	-0.027	0.006	0.004	1.000	0.016	**0.036**	-0.023	-0.025	**0.091**	**-0.058**
(13)BADNEWS_A	**-0.037**	**0.106**	**-0.038**	**0.125**	**-0.041**	**0.084**	**-0.034**	**0.044**	**0.057**	0.026	-0.009	1.000	**-0.723**	**0.089**	**0.098**	**-0.131**	0.020
(14)SUE_A	**0.066**	**-0.041**	**0.053**	**-0.057**	**0.056**	**-0.110**	**0.037**	**-0.048**	-0.004	-0.023	**0.035**	**-0.433**	1.000	-0.015	0.009	**0.226**	0.004
(15)LOGAF	-0.016	-0.023	**-0.035**	**-0.033**	**-0.039**	-0.012	**-0.039**	**0.347**	**0.040**	0.027	**-0.032**	**0.087**	**-0.065**	1.000	**0.167**	-0.001	**0.048**
(16)DISP	**-0.057**	**-0.037**	**-0.069**	**-0.037**	**-0.065**	**-0.039**	**-0.050**	**0.107**	**0.070**	-0.014	**-0.046**	**0.047**	-0.026	0.026	1.000	-0.012	0.028
(17)ABRET_A	**-0.060**	**-0.210**	**-0.063**	**-0.252**	**-0.063**	**-0.294**	**-0.063**	-0.011	**-0.032**	0.000	**0.086**	**-0.154**	**0.256**	0.001	-0.006	1.000	**0.216**
(18)ABRET	**-0.148**	**-0.097**	**-0.234**	**-0.097**	**-0.235**	**-0.087**	**-0.263**	0.014	-0.007	0.003	**-0.059**	0.011	-0.006	0.020	**0.030**	**0.199**	1.000

Table 2. Information Transfers:
Changes in Implied Volatility around the First Announcer's Earnings Announcement

This table reports results of estimating Model (1), the multivariate regression of peer firms' changes in implied volatilities on the first announcer's changes in implied volatilities. The sample contains 24,232 firm-quarter observations spanning the 1996 to 2017 period. All variables are defined in Appendix A. *p*-values are calculated using standard errors clustered by industry and are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	ΔIV_Peers											
	Full Sample				IV Decreasers: ΔIV_A<0				IV Increasers: ΔIV_A>0			
Option Duration	30-day	122-day	182-day	365-day	30-day	122-day	182-day	365-day	30-day	122-day	182-day	365-day
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
ΔIV_A	0.051***	0.071***	0.091***	0.145***	0.043***	0.064***	0.051*	0.089*	0.052**	0.040*	0.120**	0.396***
	(0.000)	(0.000)	(0.000)	(0.002)	(0.002)	(0.000)	(0.099)	(0.091)	(0.045)	(0.076)	(0.012)	(0.000)
SIZE	-0.001	-0.002***	-0.001***	0.000	-0.001**	-0.003***	-0.002***	-0.002**	0.002*	0.001	0.002***	0.004***
	(0.159)	(0.000)	(0.003)	(0.364)	(0.031)	(0.000)	(0.000)	(0.013)	(0.059)	(0.273)	(0.007)	(0.000)
LEV	-0.002	-0.003	0.000	0.001	-0.002	-0.006*	-0.004	-0.001	-0.012**	0.004	0.008*	0.002
	(0.498)	(0.289)	(0.969)	(0.674)	(0.725)	(0.074)	(0.163)	(0.753)	(0.045)	(0.356)	(0.082)	(0.725)
B/M	-0.003	-0.002	-0.001	-0.001	-0.000	-0.002	-0.003	-0.004*	-0.014**	-0.001	0.003	0.005
	(0.311)	(0.145)	(0.757)	(0.602)	(0.860)	(0.220)	(0.237)	(0.060)	(0.020)	(0.697)	(0.202)	(0.174)
ΔVIX	0.141***	0.090***	0.083***	0.057***	0.135***	0.081***	0.080***	0.060***	0.163***	0.094***	0.083***	0.053***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.005)
BADNEWS_A	-0.001	-0.002	-0.000	-0.001	-0.001	0.001	0.000	-0.001	-0.002	-0.008***	0.000	-0.001
	(0.508)	(0.133)	(0.959)	(0.812)	(0.741)	(0.597)	(0.853)	(0.777)	(0.685)	(0.005)	(0.997)	(0.837)
SUE_A	0.174	0.024	0.099	0.101	0.144	0.067	0.176	0.090	0.038	-0.236**	0.125	0.186*
	(0.128)	(0.730)	(0.171)	(0.173)	(0.170)	(0.475)	(0.123)	(0.361)	(0.917)	(0.014)	(0.193)	(0.063)
LOGAF	0.001	0.001	0.000	0.001	-0.000	0.001	-0.000	0.000	0.006**	0.001	0.001	0.002
	(0.231)	(0.234)	(0.677)	(0.448)	(0.863)	(0.502)	(0.574)	(0.705)	(0.015)	(0.370)	(0.512)	(0.349)
DISP	-0.028**	-0.006	-0.008	-0.010	-0.026*	-0.006	-0.003	-0.005	-0.027	-0.002	-0.012	-0.021*
	(0.016)	(0.291)	(0.288)	(0.167)	(0.067)	(0.403)	(0.730)	(0.639)	(0.184)	(0.849)	(0.420)	(0.099)
ABRET_A	-0.019	-0.004	0.002	-0.011	-0.007	0.009	-0.001	-0.022	-0.038	-0.001	0.001	0.035
	(0.181)	(0.684)	(0.881)	(0.552)	(0.598)	(0.357)	(0.932)	(0.246)	(0.164)	(0.943)	(0.973)	(0.264)
ABRET	-0.206***	-0.184***	-0.172***	-0.160***	-0.193***	-0.176***	-0.162***	-0.144***	-0.245***	-0.198***	-0.187***	-0.187***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.060***	0.037***	-0.017	0.007	0.047***	-0.014*	0.005	-0.028***	0.058***	0.067***	-0.019**	-0.026
	(0.000)	(0.000)	(0.185)	(0.370)	(0.005)	(0.090)	(0.897)	(0.000)	(0.003)	(0.000)	(0.034)	(0.124)
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	24,232	24,034	12,778	4,999	19,139	16,862	8,842	3,261	5,093	7,172	3,936	1,738
Adjusted R^2	0.097	0.132	0.165	0.209	0.086	0.105	0.128	0.158	0.120	0.156	0.178	0.241

Table 3. Cross-sectional Test on Information Transfers: Earnings Quality

This table reports results of the cross-sectional test conditional on the first announcer's earnings quality. The first announcer is the first firm to release earnings in the industry-quarter, where industry is defined at the 4-digit SIC level. The test is conducted for the subsample of first announcers with decreasing implied volatilities around earnings announcements. Earnings quality is measured by accruals quality. We estimate Model (1) separately for the subsample of first announcers with high and low earnings quality. All variables are defined in Appendix A. *p*-values are calculated using standard errors clustered by industry and are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	ΔIV_Peers			
	High EQ Announcers		Low EQ Announcers	
Option Duration	122-day	182-day	122-day	182-day
	(1)	(2)	(3)	(4)
ΔIV_A	0.113***	0.065**	-0.020	-0.001
	(0.006)	(0.033)	(0.650)	(0.981)
SIZE	-0.004***	-0.004***	-0.001	-0.001
	(0.001)	(0.001)	(0.224)	(0.112)
LEV	-0.006	-0.007	-0.006*	-0.002
	(0.415)	(0.276)	(0.098)	(0.527)
B/M	-0.004	-0.002	0.001	-0.001
	(0.244)	(0.516)	(0.727)	(0.736)
ΔVIX	0.081***	0.092***	0.068***	0.063***
	(0.000)	(0.000)	(0.000)	(0.000)
BADNEWS_A	-0.000	0.001	0.002	-0.001
	(0.975)	(0.744)	(0.506)	(0.794)
SUE_A	0.448***	0.337***	0.233*	-0.013
	(0.000)	(0.000)	(0.082)	(0.944)
LOGAF	0.004**	0.002	-0.005***	-0.003**
	(0.019)	(0.220)	(0.001)	(0.031)
DISP	-0.003	-0.001	-0.014	-0.001
	(0.783)	(0.959)	(0.314)	(0.957)
ABRET_A	-0.002	0.004	-0.007	0.004
	(0.937)	(0.843)	(0.679)	(0.841)
ABRET	-0.177***	-0.164***	-0.170***	-0.156***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.025	-0.040	-0.017***	-0.020***
	(0.273)	(0.146)	(0.009)	(0.000)
Quarter FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations	3,294	3,310	4,013	3,934
Adj. R^2	0.171	0.185	0.122	0.121
Test of the difference in *ΔIV_A*	(1) and (3)		(2) and (4)	
Chi-square	5.623		1.730	
P-value	0.018		0.188	

Table 4. Cross-sectional Test on Information Transfers: Good News vs. Bad news

This table reports results of the cross-sectional test conditional on the signs of the first announcer's earnings surprises. The first announcer is the first firm to release earnings in the industry-quarter, where industry is defined at the 4-digit SIC level. The test is conducted for the subsample of first announcers with decreasing implied volatilities around earnings announcements. We estimate Model (1) separately for the subsample of first announcers with positive and negative earnings surprise. All variables are defined in Appendix A. *p*-values are calculated using standard errors clustered by industry and are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	ΔIV_Peers			
	Good News Announcers		Bad News Announcers	
Option Duration	122-day	182-day	122-day	182-day
	(1)	(2)	(3)	(4)
ΔIV_A	0.092***	0.084***	0.055	-0.054
	(0.000)	(0.000)	(0.149)	(0.233)
SIZE	-0.003***	-0.002***	0.000	-0.001
	(0.000)	(0.000)	(0.793)	(0.287)
LEV	-0.004	-0.003	-0.010	-0.009
	(0.333)	(0.369)	(0.152)	(0.248)
B/M	-0.002	-0.003	-0.003	-0.003
	(0.502)	(0.152)	(0.505)	(0.590)
ΔVIX	0.070***	0.070***	0.092***	0.071***
	(0.000)	(0.000)	(0.000)	(0.000)
SUE_A	0.632***	0.277	0.112	-0.026
	(0.000)	(0.164)	(0.506)	(0.866)
LOGAF	-0.000	-0.000	-0.002	-0.002
	(0.911)	(0.726)	(0.230)	(0.341)
DISP	-0.007	-0.001	-0.003	-0.001
	(0.377)	(0.929)	(0.835)	(0.959)
ABRET_A	-0.003	0.003	0.019	0.024
	(0.823)	(0.800)	(0.508)	(0.387)
ABRET	-0.175***	-0.164***	-0.202***	-0.170***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-0.009	-0.024	0.047**	0.069***
	(0.308)	(0.486)	(0.013)	(0.000)
Quarter FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations	7,128	7,096	1,758	1,746
Adj. R^2	0.124	0.128	0.218	0.192
Test of the difference in *ΔIV_A*	(1) and (3)		(2) and (4)	
Chi-square	0.788		7.208	
P-value	0.375		0.007	

Table 5. Cross-sectional Test on Information Transfers: Industry Bellwether

This table reports results of cross-sectional tests conditional on whether the first announcer is a bellwether firm. The first announcer is the first firm to release earnings in the industry-quarter, where industry is defined at the 4-digit SIC level. The test is conducted for the subsample of first announcers with decreasing implied volatilities around earnings announcements. Panel A reports results from estimating Model (1) separately the subsample of first announcers who are in the S&P 500 index and the subsample of first announcers who are not in the S&P 500 index. Panel B reports results from estimating Model (1) separately for the large (above the quarterly median) and small (below the quarterly median) first announcers. All variables are defined in Appendix A. *p*-values are calculated using standard errors clustered by industry and are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A. S&P500 vs. Non-S&P500 First Announcers

	ΔIV_Peers			
	S&P500 Announcers		Non-S&P500 Announcers	
Option duration	122-day	182-day	122-day	182-day
	(1)	(2)	(3)	(4)
ΔIV_A	0.129***	0.123***	0.029	-0.020
	(0.000)	(0.000)	(0.432)	(0.619)
SIZE	-0.003***	-0.003***	-0.001	-0.000
	(0.001)	(0.000)	(0.216)	(0.564)
LEV	-0.002	-0.001	-0.012**	-0.009
	(0.758)	(0.637)	(0.042)	(0.141)
B/M	-0.001	-0.001	-0.004	-0.005
	(0.788)	(0.536)	(0.208)	(0.163)
ΔVIX	0.078***	0.076***	0.106***	0.089***
	(0.000)	(0.000)	(0.000)	(0.000)
BADNEWS_A	0.001	-0.001	0.002	0.001
	(0.711)	(0.699)	(0.513)	(0.676)
SUE_A	0.395	0.227	0.162	-0.042
	(0.319)	(0.622)	(0.132)	(0.706)
LOGAF	-0.001	-0.001	0.001	-0.000
	(0.229)	(0.438)	(0.592)	(0.721)
DISP	-0.002	0.001	-0.009	0.002
	(0.845)	(0.898)	(0.471)	(0.878)
ABRET_A	-0.011	-0.002	0.024	0.021
	(0.568)	(0.937)	(0.142)	(0.176)
ABRET	-0.156***	-0.142***	-0.205***	-0.198***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.016	0.101	-0.014	-0.034
	(0.269)	(0.308)	(0.151)	(0.172)
Quarter FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations	4,910	4,862	3,976	3,980
Adj. R^2	0.123	0.132	0.157	0.149
Test of the difference in *ΔIV_A*	(1) and (3)		(2) and (4)	
Chi-square	5.553		9.032	
P-value	0.018		0.003	

Table 5 continued.

Panel B: Large vs. Small First Announcers

	ΔIV_Peers			
	Large Announcers		Small Announcers	
Option duration	122-day	182-day	122-day	182-day
	(1)	(2)	(3)	(4)
ΔIV_A	0.112***	0.102***	0.036	-0.027
	(0.000)	(0.000)	(0.299)	(0.473)
SIZE	-0.003***	-0.003***	-0.000	0.000
	(0.000)	(0.000)	(0.885)	(0.865)
LEV	-0.003	-0.004*	-0.008	-0.001
	(0.542)	(0.085)	(0.258)	(0.909)
B/M	-0.005	-0.004*	-0.000	-0.002
	(0.164)	(0.095)	(0.881)	(0.551)
ΔVIX	0.078***	0.078***	0.108***	0.078***
	(0.000)	(0.000)	(0.000)	(0.000)
BADNEWS_A	0.002	0.000	0.001	0.003
	(0.409)	(0.898)	(0.715)	(0.445)
SUE_A	-0.026	-0.004	0.083	-0.013
	(0.906)	(0.985)	(0.487)	(0.934)
LOGAF	-0.000	0.001	-0.001	-0.004**
	(0.741)	(0.293)	(0.701)	(0.014)
DISP	-0.009	-0.002	0.010	0.007
	(0.343)	(0.854)	(0.495)	(0.565)
ABRET_A	-0.018	-0.004	0.031	0.015
	(0.266)	(0.832)	(0.150)	(0.390)
ABRET	-0.159***	-0.154***	-0.209***	-0.186***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.009	0.003	-0.015	0.032
	(0.398)	(0.734)	(0.212)	(0.656)
Quarter FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations	5,738	5,651	3,148	3,191
Adj. R^2	0.124	0.136	0.163	0.145
Test of the difference in *ΔIV_A*	(1) and (3)		(2) and (4)	
Chi-square	2.965		7.934	
P-value	0.085		0.005	

Table 6. Information Transfers: Macroeconomic Uncertainty

This table reports results of cross-sectional tests conditional on measures of macroeconomic uncertainty. The first announcer is the first firm to release earnings in the industry-quarter, where industry is defined at the 4-digit SIC level. The test is conducted for the subsample of first announcers with decreasing implied volatilities around earnings announcements. Panel A reports results of estimating Model (1) conditional on whether the announcing date is during an economic recession. Panel B reports results of estimating Model (1) conditional on the level of market anxiety, as proxied by the anxious index. All variables are defined in Appendix A. *p*-values are calculated using standard errors clustered by industry and are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A. Recession

	ΔIV_Peers	
Option duration	122-day	182-day
	(1)	(2)
ΔIV_A	0.050*	0.031
	(0.066)	(0.263)
*ΔIV_A*RECESSION*	0.189***	0.184*
	(0.007)	(0.060)
RECESSION	0.011	-0.026
	(0.313)	(0.419)
SIZE	-0.002***	-0.002***
	(0.000)	(0.000)
LEV	-0.006	-0.004
	(0.129)	(0.160)
B/M	-0.002	-0.003
	(0.394)	(0.221)
ΔVIX	0.082***	0.079***
	(0.000)	(0.000)
BADNEWS_A	0.001	0.000
	(0.520)	(0.933)
SUE_A	0.301***	0.192*
	(0.002)	(0.071)
LOGAF	-0.000	-0.000
	(0.859)	(0.644)
DISP	-0.007	-0.003
	(0.388)	(0.699)
ABRET_A	0.000	-0.000
	(0.985)	(0.998)
ABRET	-0.175***	-0.161***
	(0.000)	(0.000)
Constant	-0.006	0.005
	(0.503)	(0.904)
Quarter FE	Yes	Yes
Industry FE	Yes	Yes
Observations	8,886	8,842
Adj. R^2	0.134	0.129

Table 6 continued.

Panel B: Anxious Index

	ΔIV_Peers	
Option duration	122-day	182-day
	(1)	(2)
ΔIV_A	0.004	-0.031
	(0.926)	(0.408)
*ΔIV_A*ANXIOUS*	0.111**	0.138**
	(0.035)	(0.012)
ANXIOUS	0.001	0.043
	(0.929)	(0.369)
SIZE	-0.002***	-0.002***
	(0.000)	(0.000)
LEV	-0.006	-0.004
	(0.138)	(0.163)
B/M	-0.002	-0.003
	(0.398)	(0.238)
ΔVIX	0.085***	0.080***
	(0.000)	(0.000)
BADNEWS_A	0.002	0.001
	(0.357)	(0.736)
SUE_A	0.291***	0.211*
	(0.002)	(0.078)
LOGAF	-0.000	-0.000
	(0.881)	(0.607)
DISP	-0.006	-0.003
	(0.419)	(0.749)
ABRET_A	-0.002	0.001
	(0.864)	(0.935)
ABRET	-0.176***	-0.162***
	(0.000)	(0.000)
Constant	-0.003	-0.037
	(0.771)	(0.138)
Quarter FE	Yes	Yes
Industry FE	Yes	Yes
Observations	8,886	8,842
Adj. R^2	0.133	0.128

Table 7: Information Transfers: Alternative Industry Definition

The table reports results of estimating Model (1) under alternative industry definitions for the subsample of first announcers with decreasing implied volatilities around earnings announcements. In Panel A, industry is defined at the FIC-400 level based on Hoberg and Phillips (2010, 2016). In Panel B, the first announcer is the first firm to release earnings in the industry-quarter for both 4-digit SIC and FIC-400 industries. All variables are defined in Appendix A. *p*-values are calculated using standard errors clustered by industry and are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: FIC-400 Industry Peers

	ΔIV_Peers	
Option duration	122-day	182-day
	(1)	(2)
ΔIV_A	0.070***	0.073*
	(0.001)	(0.086)
SIZE	-0.001	-0.002**
	(0.197)	(0.022)
LEV	0.002	-0.001
	(0.448)	(0.672)
B/M	0.002	-0.001
	(0.576)	(0.819)
ΔVIX	0.087***	0.072***
	(0.000)	(0.000)
BADNEWS_A	0.006*	0.004
	(0.073)	(0.224)
SUE_A	0.146	0.134
	(0.256)	(0.501)
LOGAF	-0.001	-0.002
	(0.345)	(0.207)
DISP	-0.010	-0.012
	(0.180)	(0.305)
ABRET_A	-0.012	-0.008
	(0.268)	(0.590)
ABRET	-0.120***	-0.123***
	(0.000)	(0.000)
Constant	-0.007	-0.008
	(0.641)	(0.472)
Quarter FE	Yes	Yes
Industry FE	Yes	Yes
Observations	11,757	5,973
Adj. R^2	0.109	0.113

Table 7 continued.

Panel B: 4-digit SIC vs. FIC-400 Industry Peers

	ΔIV_Peers			
	4-digit SIC		FIC400	
Option duration	122-day	182-day	122-day	182-day
	(1)	(2)	(3)	(4)
ΔIV_A	0.063***	0.047**	0.054**	-0.016
	(0.004)	(0.042)	(0.024)	(0.597)
SIZE	-0.002*	-0.002***	-0.000	-0.001
	(0.062)	(0.000)	(0.804)	(0.397)
LEV	-0.002	-0.002	0.001	-0.004
	(0.707)	(0.492)	(0.660)	(0.312)
B/M	-0.001	-0.004	-0.001	-0.001
	(0.517)	(0.161)	(0.729)	(0.872)
ΔVIX	0.085***	0.062***	0.083***	0.082***
	(0.000)	(0.000)	(0.000)	(0.000)
BADNEWS_A	0.003	0.003	0.005*	0.007**
	(0.269)	(0.369)	(0.098)	(0.032)
SUE_A	0.117	0.362	0.215	0.394*
	(0.459)	(0.122)	(0.211)	(0.078)
LOGAF	-0.000	-0.001	-0.002	-0.002*
	(0.892)	(0.453)	(0.110)	(0.093)
DISP	-0.016	-0.011	-0.017	-0.014
	(0.150)	(0.356)	(0.101)	(0.242)
ABRET_A	0.003	0.003	-0.028**	-0.027
	(0.812)	(0.856)	(0.043)	(0.126)
ABRET	-0.174***	-0.167***	-0.131***	-0.142***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.071***	-0.004	-0.013	-0.001
	(0.000)	(0.727)	(0.293)	(0.397)
Quarter FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations	7,970	4,368	7,228	3,981
Adj. R^2	0.134	0.163	0.108	0.093
Test of the difference in *ΔIV_A*	(1) and (3)		(2) and (4)	
Chi-square	0.09		2.89	
P-value	0.761		0.089	

Table 8. Information Transfers: Uncertainty about Firm Fundamentals vs. Prices

This table reports results of cross-sectional tests conditional on the extent to which the change in implied volatilities reflects the change in uncertainty about firm fundamentals. We use dispersion in analysts' earnings forecasts to proxy for fundamental uncertainty. The first announcer is the first firm to release earnings in the industry-quarter, where industry is defined at the 4-digit SIC level. The test is conducted for the subsample of first announcers with decreasing implied volatilities around earnings announcements. Columns (1) and (2) report results of estimating Model (1) for the subsample of first announcers whose implied volatility and analyst forecast dispersion both decrease ("Same Subsample"). Columns (3) and (4) report results estimating Model (1) for the subsample of first announcers whose implied volatility and analyst forecast dispersion change in the opposite direction ("Opposite Subsample"). All variables are defined in Appendix A. *p*-values are calculated using standard errors clustered by industry and are reported in parentheses. *, **, and *** denote statistical significance at the 10%, 5%, and 1% levels, respectively.

	ΔIV_Peers			
	Same Subsample		Opposite Subsample	
Option duration	122-day	182-day	122-day	182-day
	(1)	(2)	(3)	(4)
ΔIV_A	0.115***	0.144***	0.052*	0.065*
	(0.000)	(0.000)	(0.091)	(0.088)
SIZE	-0.003***	-0.003***	-0.002**	-0.001
	(0.000)	(0.000)	(0.014)	(0.129)
LEV	-0.005	-0.002	-0.002	-0.007
	(0.293)	(0.544)	(0.548)	(0.265)
B/M	-0.001	-0.002	-0.002	-0.002
	(0.560)	(0.483)	(0.458)	(0.526)
ΔVIX	0.068***	0.057***	0.120***	0.111***
	(0.000)	(0.000)	(0.000)	(0.000)
BADNEWS_A	-0.004	-0.007***	0.004	0.006
	(0.147)	(0.010)	(0.174)	(0.154)
SUE_A	0.272*	0.240***	-0.003	0.202
	(0.083)	(0.006)	(0.986)	(0.451)
LOGAF	0.001	-0.000	-0.001	-0.002
	(0.448)	(0.827)	(0.660)	(0.423)
DISP	-0.006	0.010	-0.015*	-0.026**
	(0.459)	(0.339)	(0.093)	(0.011)
ABRET_A	-0.001	-0.003	0.021	0.023
	(0.929)	(0.880)	(0.193)	(0.308)
ABRET	-0.183***	-0.160***	-0.153***	-0.148***
	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.050***	-0.001	0.019**	0.150
	(0.000)	(0.973)	(0.023)	(0.188)
Quarter FE	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes
Observations	8,945	4,945	5,235	2,811
Adj. R^2	0.115	0.138	0.101	0.132
Test of the difference in *ΔIV_A*	(1) and (3)		(2) and (4)	
Chi-square	2.86		2.74	
P-value	0.091		0.098	