

# Risk Premiums and Non-Diversifiable Earnings Announcement Risk

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## **Abstract**

This study seeks to determine whether non-diversifiable earnings announcement risk is associated with risk premiums reflected in option prices. Following prior research, we use option prices to extract an *ex ante* measure of implied announcement volatility and compare it to realized announcement volatility. We find that option prices reflect implied announcement volatility that exceeds realized volatility when the announcement risk is non-diversifiable, which is consistent with option prices reflecting a risk premium that manifests as higher implied volatility. Additionally, we find that excess implied volatility is higher for larger firms, industry leaders, and firms whose earnings are both more sensitive to aggregate earnings factors and convey more news. In addition, we find that S&P500 index options reflect a higher expected correlation among index components when announcement risk is non-diversifiable. Taken together, our findings establish a link between risk premiums and non-diversifiable earnings announcement risk.

**JEL:** M41, G12, G13, G14

**Keywords:** Earnings announcements, non-diversifiable risk, option pricing, risk premiums, jump volatility risk

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# **Risk Premiums and Non-Diversifiable Earnings Announcement Risk**

## **1. Introduction**

This study seeks to determine whether non-diversifiable earnings announcement risk is associated with risk premiums reflected in option prices. Earnings announcements are a central channel through which firms resolve idiosyncratic uncertainty about the value of its equity. When the earnings announcements also resolve uncertainty about the value of the market portfolio, the announcement poses risk to investors, even those with well-diversified portfolios. Often, news headlines and market analysts view earnings announcements as the impetus for contemporaneous changes in market indices, which suggests that the risk associated with some earnings announcements is not fully diversifiable.<sup>1</sup> We find cross-sectional variation in the extent to which firms' earnings announcements pose non-diversifiable risk, and provide direct evidence that non-diversifiable earnings announcement risk commands a risk premium embedded in prices of firms' traded options.

A substantial literature in accounting and finance provides evidence that systematic risk, as measured by the Capital Asset Pricing Model (CAPM) beta, is greater around earnings announcements than at other times. A related literature provides evidence of firm-specific positive abnormal equity returns at earnings announcements. However, prior research has not been able to establish a link between the increases in CAPM beta and positive abnormal announcement returns, thereby leaving open the question of whether there is increased non-diversifiable risk at earnings announcements that commands a risk premium. The absence of evidence of this link clouds the interpretation of increases in CAPM beta at earnings

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<sup>1</sup> For example, "Strong Results at Intel Pull Stocks Sharply Higher" states "Strong earnings and an upbeat forecast from Intel Corp. pulled investors into the stock market Wednesday as hopes grew that the economy could be starting to recover" (July 15, 2009, Associated Press on Yahoo! Finance).

announcements, as well as our understanding of whether earnings announcement risk is non-diversifiable and how it affects asset prices. Our study contributes to this literature by establishing this link.

Establishing this link requires measures of earnings announcement risk premiums and non-diversifiable earnings announcement risk. To develop our measure of earnings announcement risk premiums, we first extract from prices of a firm's traded options an *ex ante* measure of equity volatility investors expect at the firm's earnings announcement, i.e., implied announcement volatility. The greater is implied announcement volatility, the greater is earnings announcement risk. To extract this measure we build on prior research, including recent advances in option pricing, and specify expected earnings announcement volatility as a mixture of a firm's expected baseline volatility and an increase in expected volatility associated with the earnings announcement. To validate our measure, we compare the implied announcement volatility with realized announcement volatility and firm characteristics prior research finds are associated with equity price reactions to earnings announcements. These characteristics are the firm's size, equity book-to-market ratio, market share, average historical absolute quarterly earnings announcement return, dispersion in analyst forecasts, and absolute analyst earnings forecast errors. We find that the implied announcement volatility we measure is generally realized and has predictable relations with these firm characteristics. These findings indicate that our measure has validity as an *ex ante* measure of expected earnings announcement risk.

To develop our proxy for earnings announcement risk premiums, we next construct a measure of excess implied announcement volatility by comparing implied announcement volatility to realized announcement volatility. This excess implied volatility, i.e., announcement volatility implied by option prices that is in excess of realized announcement volatility, is our

proxy for the earnings announcement risk premium embedded in option prices. The price of an option compensates the writer for bearing risk associated with whether, and at what price, the option will be exercised. The writer will demand a risk premium, in the form of higher prices, to the extent the writer anticipates macroeconomic news to increase the volatility of returns for all assets comprising the market portfolio. Excess implied volatility reflects a risk premium embedded in option prices because excess volatility reveals that option writers demand higher option prices than would be justified by realized volatility alone. Excess implied announcement volatility indicates option writers demand a premium for bearing earnings announcement risk.

To capture non-diversifiable risk directly associated with earnings announcements, we develop three measures of non-diversifiable earnings announcement risk. The first is the comovement of the firm's equity return and the market return at the firm's prior earnings announcements. We expect that earnings announcement risk is non-diversifiable when the earnings announcement conveys macroeconomic news to the market. If this is the case, there will be a parallel price reaction for the announcing firm and the market portfolio. The second measure is the increase in the firm's historical quarterly earnings announcement CAPM beta relative to non-earnings announcement periods. CAPM beta is a widely accepted measure of non-diversifiable risk and prior research shows that beta increases around earnings announcements, which suggests the presence of non-diversifiable earnings announcement risk. The third measure is the number of firms with the same earnings announcement date as the announcing firm. We expect that the greater is the number of other firms announcing earnings on the day the firm announces its earnings, the more aggregate earnings news is conveyed to the market and, thus, the less likely it is that the firm's investors can diversify the news conveyed by its announcement.

The tests of our main research question focus on establishing a cross-sectional relation between our measures of risk premiums embedded in option prices and non-diversifiable earnings announcement risk. We find a significant positive relation between all three of our measures of non-diversifiable earnings announcement risk and excess implied announcement volatility reflected in option prices, which is our proxy for earnings announcement risk premiums. Our evidence is based on a sample of over 45,000 quarterly earnings announcements between 1996 and 2007 by firms with publicly traded equity and traded options. Our findings are strongest for the extent to which the firm's earnings announcement return in the past has been the same as the market return on the day of the firm's announcement. Our inferences are robust to using alternative approaches to determine the earnings announcement date, and apply regardless of whether earnings announcements convey good or bad news, the firm issues management earnings guidance prior to the announcement, and the firm is larger or smaller. We find no evidence of a positive relation between non-diversifiable earnings announcement risk and excess implied announcement volatility during non-announcement periods, which supports our inference that earnings news is crucial to eliciting risk premiums. Taken together, our findings establish a significant positive relation between risk premiums and non-diversifiable earnings announcement risk.

We also find that excess implied announcement volatility is greater for larger firms and industry leaders, incremental to our announcement-specific measures of non-diversifiable risk. The positive relation between excess implied volatility and firm size is consistent with our primary inferences because size is an alternative proxy for the extent to which the risk associated with a firm's earnings news is non-diversifiable. In addition, finding a positive relation with firm size helps rule out the possibility that excess implied volatility reflects option mispricing

rather than risk premiums. Smaller firms, not larger firms, are more likely to suffer from option mispricing because market frictions are more likely to hinder arbitrage for smaller firms.

Additional analyses support the inference that earnings announcements can be a mechanism through which macroeconomic news is conveyed to investors. Prior research demonstrates that a substantial portion of firm-level earnings can be explained by common earnings factors, which implies that earnings shocks have substantial systematic components and are not almost fully diversifiable. We find that excess implied announcement volatility is significantly larger when the firm's announced earnings is both more sensitive to aggregate earnings factors and conveys more news to the market. This finding establishes a link between aggregate earnings factors and earnings announcement risk premiums.

Finally, we investigate whether the expected correlation of equity returns for firms in the S&P500 index is positively related to the amount of expected non-diversifiable earnings news. As predicted, we find that S&P500 index option prices reflect a higher expected correlation between equity returns of the firms comprising the index for months in which firms with greater non-diversifiable earnings announcement risk announce earnings. This finding helps establish that the market anticipates a higher likelihood of macroeconomic news being conveyed through earnings announcements by firms with greater non-diversifiable earnings announcement risk.

The paper proceeds as follows. Section 2 reviews related research and section 3 develops the elements of the research design. Section 4 describes the sample, data, and descriptive statistics, and section 5 presents the findings relating to earnings announcement risk and risk premiums. Section 6 relates non-diversifiable earnings announcement risk to expected correlation of equity returns for firms in the S&P500 index. Section 7 offers concluding remarks.

## 2. Related Research

Our study relates to and links three primary streams of literature. The first is the literature that documents positive abnormal equity returns and higher CAPM betas at earnings announcements. The second is the literature that documents jumps in equity prices and higher equity volatility at earnings announcements, and shows how equity volatility implied by traded option prices can be used to obtain a measure of announcement-specific risk. The third is the literature on non-diversifiable earnings news.

### *2.1. Positive equity returns and increases in beta*

Epstein and Turnbull (1980) finds that the risks associated with holding equity are time-varying, which could result from risk associated with earnings announcements. Consistent with this possibility, several studies find that CAPM betas increase around earnings announcements. Ball and Kothari (1991) estimates CAPM betas in event time for the 20 days surrounding quarterly earnings announcements, and finds higher beta on days  $t - 1$  and  $t + 1$  relative to earnings announcement day  $t$ . Hsieh, Jerris, and Kross (1999) extends Ball and Kothari (1991) to individual firms using a time-series approach and also finds evidence of higher betas around earnings announcements. Patten and Verardo (2010) uses daily firm-level betas estimated from intraday prices and finds that betas significantly increase during earnings announcements.

These findings suggest that earnings announcements are associated with an increase in non-diversifiable risk relative to non-announcement periods. Consistent with this possibility, several studies find positive abnormal equity returns at earnings announcements (e.g., Chambers and Penman, 1984; Penman 1984, 1987; Chari, Jagannathan, and Ofer, 1988; Ball and Kothari, 1991). Lamont and Frazzini (2007) also finds that earnings announcement returns are particularly large for large firms.

However, prior research does not establish a link between the increase in CAPM beta, which is evidence of an increase in non-diversifiable risk at earnings announcements, and the positive abnormal earnings announcement returns. Although Ball and Kothari (BK, 1991) and Patten and Verardo (2010) find both higher betas and positive announcement abnormal returns, these studies do not test for a link between the two. Hsieh, Jerris, and Kross (1999) conducts such tests, but fails to find a significant difference in announcement returns across portfolios formed based on the magnitude of announcement-specific betas.<sup>2</sup> Consistent with this failure to find a significant relation, BK observes only a marginal increase in information at earnings announcements that covaries with the market return relative to non-announcement periods, and concludes that earnings information results in primarily diversifiable risk. Also, Ball, Sadka, and Sadka (2009) interprets the overall conclusion of extant research to be that earnings shocks are almost fully diversifiable.<sup>3,4</sup>

Cohen, Dey, Lys, and Sunder (CDLS, 2007) revisits the existence of positive announcement returns, in part because of the many changes in institutions and markets since the early 1990s. CDLS finds such returns, although the magnitudes are smaller than those reported in Ball and Kothari (BK, 1991). CDLS interprets this finding, together with finding higher realized equity volatility at earnings announcements than reported in BK, as consistent with

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<sup>2</sup> Relating to quarterly dividend announcements, Kalay and Lowenstein (1985) and Eades, Hess, and Kim (1985) investigate whether the announcement affects equity risk around the announcement dates. Kalay and Lowenstein (1985) finds positive returns and a significant increase in beta, but the increase in beta does not explain the return. Eades, Hess, and Kim (1985) also finds positive returns but finds no evidence of a change in beta around the announcements.

<sup>3</sup> Our findings are not necessarily at odds with the conclusions of BK and Ball, Sadka, and Sadka (2009). In particular, we do not find that all earnings announcements pose non-diversifiable risk. Rather, we find cross-sectional variation in non-diversifiable earnings announcement risk. Prior studies may have reached conclusions seemingly opposite to ours either because of using realized returns, which are noisy measures of expected returns, rather than expectations embedded in option prices, or because the studies pool all earnings announcements together rather than allowing for the cross-sectional variation we document.

<sup>4</sup> This interpretation is consistent with studies examining cash flow news and cash flow variation. For example, Vuolteenaho (2002) concludes that although news about expected returns is correlated across firms, news about cash flows is largely diversifiable, and Cochrane (2001) concludes that much of the expected cash flow variation is idiosyncratic.



changes in the amount and cost of arbitrage. That is, CDLS interprets the positive announcement returns as evidence of a market anomaly, i.e., mispricing, that is too costly to arbitrage away, rather than as compensation for bearing non-diversifiable risk over an earnings announcement period.<sup>5</sup>

Thus, the extant literature does not establish a link between the higher betas, and thus higher systematic risk, at earnings announcements and the positive abnormal earnings announcement returns, which could represent premiums for bearing that higher risk. We contribute to this literature by establishing this link. Establishing this link is necessary because a substantial literature in finance and economics casts doubt on the use of CAPM betas as a sufficient statistic for risk and risk premiums. A central prediction of the CAPM is that expected returns are positively and linearly related to beta. Early empirical tests reject the CAPM by noting that the relation between beta and average returns is too flat, in that estimated betas are consistently less than the average excess market return (Black, Jensen, and Scholes, 1972; Stambaugh, 1982). In addition, Fama and French (1992) finds that beta is negatively, not positively, related to realized returns after controlling for firm size. Fama and French (2004) summarize the concern about beta as a measure of non-diversifiable risk by stating “The version of the CAPM developed by Sharpe (1964) and Linter (1965) has never been an empirical success. . . . The problems are serious enough to invalidate most applications of the CAPM.” [p. 43]. Thus, although estimated betas capture the extent to which asset returns covary, without

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<sup>5</sup> Kim and Verrecchia (1991a) demonstrates that the market reaction to earnings news is increasing in the precision of the news and decreasing in the precision of pre-announcement news. Kim and Verrecchia (1991b) examines how the market reaction to earnings news varies with investors’ risk tolerances and incentives to gather costly private information. Both studies provide interpretations for realized market reactions to earnings news, whereas we examine differences between expected and realized market reactions to earnings news. Our findings suggest that non-diversifiable earnings announcement risk also affects the market reaction to earnings news.

additional evidence finding that betas are higher at earnings announcements does not establish that non-diversifiable earnings announcement risk commands a risk premium.

## 2.2. Price jumps and equity volatility implied by option prices

Beginning with Ball and Brown (1968) and Beaver (1968), research in accounting and finance documents large, rapid equity price reactions to earnings announcements. Patell and Wolfson (1984) uses newswire time stamps associated with earnings announcements and finds that most of the price reaction to the announcements occurs within the first few minutes. This near-instantaneous price reaction suggests the existence of discontinuities, or jumps, in the time series of equity prices in response to earnings news.

Consistent with jumps in prices at earnings announcements, prior research also documents higher volatility of equity returns around earnings announcements (e.g., Beaver, 1968; Patell and Wolfson, 1981).<sup>6</sup> Observing that for most firms the timing of earnings announcements is the same from period to period, Patell and Wolfson (1979, 1981) test for *ex ante* information content of earnings announcements by examining changes in equity volatility implied by traded call option prices. Patell and Wolfson (1979, 1981) find that implied volatility increases prior to earnings announcements and decreases afterwards. These findings are consistent with a deterministic increase in equity volatility around earnings announcements and with option traders anticipating the increase. The findings also indicate that option prices reflect investor expectations of increased volatility relating to earnings announcements and, thus, that option traders anticipate that earnings announcements will convey information to the equity market. Building upon Patell and Wolfson (1979, 1981), Billings and Jennings (2010) finds that

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<sup>6</sup> Relatedly, Kim and Verrecchia (1994) models variation across investors in their interpretation of earnings news, which can increase the asymmetric information component of bid-ask spreads at the earnings announcement. This increase in bid-ask spreads can mechanically increase equity volatility because of the bid-ask bounce. Our findings provide additional insights into the determinants of announcement risk by showing that earnings announcements of some firms convey non-diversifiable earnings news.

option prices reflect anticipated increases in equity volatility as well as information regarding earnings persistence, growth prospects, and characteristics of the information environment.

Focusing on management earnings forecasts rather than earnings announcements, Rogers, Skinner, and Van Buskirk (RSV, 2009) examines how implied volatility changes, and finds that negative (positive) management earnings forecasts increase (decrease) uncertainty as reflected in implied volatility. The research approach in RSV is similar to that in Patell and Wolfson (1979, 1981). However, RSV examines *ex post* changes in implied volatility to determine the effects of management guidance on investor uncertainty, whereas Patell and Wolfson (1979, 1981) use both *ex ante* and *ex post* implied volatilities to measure uncertainty associated with earnings announcements. Our study is similar to these studies in that we use implied volatility to infer the effect of information events on risk; our study differs in that we focus on the premiums associated with the risk and not on the amount of the risk *per se*.

Merton (1973) extends the Black and Scholes (1974) option-pricing formula by showing that equity volatility implied by option prices should equal the average variance of equity returns between the date of the option price and the expiration of the option. This extension has two implications relevant to our study given that earnings announcements create jumps in equity prices. First, the Merton (1973) extension shows that equity return volatility in the Black and Scholes (1974) option-pricing formula can be expressed as the weighted average of baseline diffusive volatility and jump volatility associated with an anticipated information event. The Patell and Wolfson (1979, 1981) measures of implied volatility rely on option-pricing models that assume a continuous price path, but this assumption is inconsistent with evidence that earnings announcements convey information that is a surprise to equity investors (Huang, 1985). More recently, Piazzesi (2001, 2005) develop option-pricing models that incorporate jumps in

equity prices in response to macroeconomic events. Dubinsky and Johannes (2006) finds that incorporating equity price jumps in the model significantly reduces option-pricing errors, and that uncertainty around earnings announcements plays a central role in determining option prices for a sample of 20 firms from 1996 to 2002.

Second, the Merton (1973) extension shows that implied and realized volatility should be equal, on average, in the absence of additional priced risk. Yet, Jackwerth and Rubinstein (1996) and Pan (2002) find that equity volatility implied by prices of S&P500 index options is higher than subsequently realized volatility. Although the difference between implied and realized volatility could be attributable to a lack of integration between the options and equity markets, Pan (2002) shows that jump risk can explain the difference. In particular, Pan (2002) develops a stochastic volatility model that allows for jumps in equity prices and estimates the joint time series of S&P index option implied and realized volatilities. Pan (2002) finds that equity price jump volatility risk results in implied volatility that is systematically larger than realized volatility.<sup>7</sup> Because investors demand a risk premium to hold assets with non-diversifiable risk, the Pan (2002) finding suggests that option traders assess a risk premium for holding the index options over a period that exposes them to jump volatility risk. Thus, this literature suggests that if an earnings announcement contains non-diversifiable risk, one would expect risk premiums associated with the announcement risk to be embedded in option prices.

Our study uses the insights from this literature to structure our tests and as a basis for interpreting our findings. In particular, first we refine the research approach in Patell and

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<sup>7</sup> The option-pricing literature also documents that highly out-of-the-money (OTM) options yield highly negative returns (e.g., Jackwerth, 2000; Borarenko, 2003). Broadie, Chernov, and Johannes (BCJ, 2007; 2009) find that observed returns to OTM written options are consistent with expectations of jumps in equity prices. The BCJ findings suggest that the large negative returns for OTM options are attributable to jump volatility risk premiums. The notion is that investors rationally invest in options with negative expected returns to hedge against future price jumps. Thus, the BCJ findings also indicate that option prices reflect information about jump risk.

Wolfson (1979; 1981) by incorporating insights from Merton (1973) and the jump risk literature to develop a more precise measure of expected equity volatility specific to earnings announcements. Second, we extend the literature comparing equity volatility implied by prices of traded S&P 500 index options and realized volatility of the index to traded options of individual firms. The refinement and extension enable us to develop a proxy for risk premiums embedded in prices of individual firm's traded options that are associated with earnings announcement risk.

### *2.3. Non-Diversifiable Earnings News*

Recent research in accounting provides evidence that aggregate earnings news is non-diversifiable because it provides information about aggregate expected returns. Focusing on management earnings guidance rather than earnings announcements, Anilowski, Feng, and Skinner (2007) provides evidence that management guidance affects aggregate stock returns by altering the market's assessment about macroeconomic performance and/or expected stock returns. Specifically, Anilowski, Feng, and Skinner (2007) finds that downward earnings guidance by large firms is associated with negative market returns.

Focusing on earnings announcements, Kothari, Lewellen, and Warner (KLW, 2006) documents a negative relation between aggregate unexpected earnings, measured as quarterly earnings minus earnings for four quarters prior, and quarterly market returns. KLW infers from this result that unexpected earnings influences market discount rates. Extending KLW and supporting its inference, Cready and Gurun (2009, 2010) document that on earnings announcement days, daily aggregate earnings is negatively related to market returns incremental to past aggregate earnings, and positively related to Treasury bond rates and expected inflation. These findings indicate that earnings news helps investors form expectations about market

discount rates, where positive (negative) earnings news is associated with increases (decreases) in the expected discount rate. Relatedly, Ball, Sadka, and Sadka (2009) uses factor analysis to extract a macroeconomic component of earnings, and concludes that because earnings are correlated across firms, risk associated with changes in earnings is unlikely to be fully diversifiable.

We extend this literature first by showing that non-diversifiable earnings announcement risk is positively related to risk premiums embedded in traded option prices. Our measures of non-diversifiable risk reflect the extent to which the equity price reaction to a firm's earnings announcement and the market return move in the same direction. In contrast, inferences in the discount rate literature are based on the firm's price reaction to earnings news moving in the opposite direction to the market return. In addition, we focus on the risk associated with earnings announcements, not the sign and magnitude of the earnings announcement return. Thus, we show that non-diversifiable earnings announcement risk is not limited to uncertainty about market discount rates. Second, we show that the macroeconomic component of earnings identified in Ball, Sadka, and Sadka (2009) is associated with risk premiums embedded in option prices when the firm's earnings announcements convey news to the market. Third, we show that the expected correlation of returns for firms comprising the S&P500 index is positively related to the amount of expected non-diversifiable earnings news. This finding supports our interpretation that earnings announcements can convey information about the broader economy and that expectations of non-diversifiable earnings announcement risk are reflected in option prices prior to the announcement.

#### *2.4. Our contribution*

Taken together, prior literature leaves open the question of whether earnings announcements pose non-diversifiable risk that is priced by investors. Our option-based approach allows us to obtain a proxy for risk premiums directly associated with the announcement by comparing implied earnings announcement equity volatility measured before the announcement and realized volatility at the announcement. We find a significantly positive cross-sectional relation between excess implied announcement volatility embedded in option prices and measures of non-diversifiable earnings announcement risk, which is consistent with excess volatility reflecting compensation for bearing non-diversifiable risk.

### **3. Research Design**

To establish a link between risk premiums and non-diversifiable earnings announcement risk, our research design proceeds in four stages. First, we extract from prices of a firm's traded options a measure of equity volatility investors expect at the firm's earnings announcement. Second, we conduct tests to establish the validity of our implied announcement equity volatility measure. Third, we construct a measure of excess implied volatility by comparing implied announcement volatility to realized announcement volatility. This excess implied volatility, i.e., implied volatility in excess of the volatility justified by realized volatility, is our proxy for the risk premium embedded in option prices. Fourth, we develop measures of earnings announcement-specific non-diversifiable risk and test whether these measures are positively associated with the earnings announcement risk premiums.

Some prior research uses signed realized equity returns to measure risk and risk premiums. We use option prices to construct our measures because doing so has several advantages over using realized equity returns. Using option prices is a natural way to obtain an

*ex ante* measure of earnings announcement risk because expected equity volatility is a key input in determining option prices and prior research establishes that equity volatility changes in a predictable pattern around earnings announcements. Using option prices also permits us to compare expected and realized earnings announcement risk, and thereby assess the extent to which the prices reflect risk premiums directly associated with earnings announcements. In addition, option markets attract sophisticated and privately informed investors. Thus, option prices are more likely to be informationally efficient than equity prices (Black, 1975; Easley, O'Hara, and Srinivas, 1998; Pan and Poteshman, 2006), which suggests that option mispricing is less likely to confound option price-based estimates of risk and risk premiums. Finally, unlike realized returns, option prices are not confounded by the realization of unanticipated cash flow news, revisions in market expectations of future cash flows, and changes in discount rates. These features of realized returns could be why prior research does not provide evidence of a significant relation between non-diversifiable earnings announcement risk and risk premiums.

### *3.1. Implied earnings announcement risk*

We follow prior research (e.g., Patell and Wolfson, 1981) to characterize equity volatility implied by option prices prior to earnings announcements as a mixture of baseline diffusive volatility and increased volatility related to the anticipated earnings announcement. Patell and Wolfson (1981) structures its tests, as do we, based on the insight in Merton (1973) that implied volatility equals the average return variance expected prior to the option expiration date.

We base our estimates of implied volatility on a model in which implied volatility equals the sum of baseline diffusive volatility and volatility associated with the anticipated jump in equity prices at the earnings announcement, averaged over the remaining life of the option



(Merton, 1973), i.e., a jump-diffusion model. This leads to the following expression of implied volatility:

$$\sigma_{t,T}^2 = \sigma^2 + T^{-1}(\sigma^{EA})^2, \quad (1)$$

where  $\sigma_{t,T}^2$  is implied volatility derived from option prices on day  $t$ ,  $\sigma^2$  is implied diffusive volatility expressed in annualized units,  $(\sigma^{EA})^2$  is implied volatility associated with anticipated price changes on the earnings announcement day, and  $T$  is the number of trading days until maturity of the option.<sup>8</sup>

Equation (1) is identical to the representation of implied volatility in Patell and Wolfson (1981), except that we assume the increase in equity volatility associated with the earnings announcement occurs on the announcement day rather than over potentially several days surrounding the announcement.<sup>9</sup> Our assumption is consistent with extant literature documenting rapid equity price changes in response to earnings announcements. It also permits a direct comparison of expected and realized announcement volatility, which, as section 3.3 explains, enables us to construct a proxy for earnings announcement risk premiums.<sup>10</sup>

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<sup>8</sup> Assume that at time  $t$  option prices reflect the market's anticipation of a single equity price change on the earnings announcement day  $\tau$ , where  $t < \tau < \bar{t} = t + T$ , and  $\bar{t}$  is the option expiration date. The price change at the earnings announcement is drawn from a distribution with variance  $(\sigma^{EA})^2$ , where  $\sigma^{EA}$  is the parameter we seek to estimate. Following Merton (1973), in a jump-diffusion model implied volatility equals the sum of baseline diffusive volatility, i.e.,  $\sigma^2$ , plus the volatility associated with the price jump averaged over the remaining life of the option, i.e.,  $T^{-1}(\sigma^{EA})^2$ . Thus, the time  $t$  implied volatility is  $\sigma_{t,T}^2 = \sigma^2 + T^{-1}(\sigma^{EA})^2$ . As explained below, our measure reflects anticipated price changes over the next 30 days, attributable to earnings announcements or to other anticipated events. Section 5.4.1 discusses additional analysis that reveals our inferences are robust to using an *ex post* measure of implied announcement volatility measured just before and just after the earnings announcement, again following Patell and Wolfson (1981), which mitigates concerns about possible effects on our inferences of other anticipated events.

<sup>9</sup> In the notation of Patell and Wolfson (1981), we assume  $\tau = 1$  and, thus, that implied volatility reverts to diffusive volatility on the day after the announcement.

<sup>10</sup> Another advantage of using a jump-diffusion model is that its implementation requires estimating two implied volatility parameters, rather than just one. This mitigates concerns about our earnings announcement implied volatility measure reflecting the effects of any model misspecification related to the prices of a firm's options. This is because  $(\sigma^{EA})^2$  captures the change in implied volatility around earnings announcements, not the level of implied

Rearranging equation (1) demonstrates that expected volatility on the earnings announcement date can be expressed as:

$$IAV_q = \sqrt{(\sigma^{EA})^2 + \sigma^2 / 252}. \quad (2)$$

We refer to this expected volatility as implied announcement volatility,  $IAV_q$ , because we measure it using volatility implied by option prices.  $IAV$  is expressed as a standard deviation. The greater is  $IAV_q$ , the greater is announcement risk. We divide  $\sigma^2$  by 252, the number of trading days in a year, to capture the contribution of baseline volatility to the total expected volatility on the announcement date. The day after the earnings announcement, implied volatility reflects only diffusive volatility, i.e.,  $(\sigma^{EA})^2 = 0$  and implied volatility equals  $\sigma^2$ .<sup>11</sup>

Because both implied volatilities in equation (1),  $\sigma^2$  and  $(\sigma^{EA})^2$ , are unknown, estimating them requires use of two option prices. We use prices of the firm's 30- and 60-day standardized at-the-money call options traded on day  $t$ . We first estimate  $(\sigma^{EA})^2$  using the following expression derived from equation (1).<sup>12</sup>

$$(\sigma^{EA})^2 = \frac{\sigma_{t,T_1}^2 - \sigma_{t,T_2}^2}{T_1^{-1} - T_2^{-1}} = \frac{\sigma_{t,30}^2 - \sigma_{t,60}^2}{\frac{252}{30} - \frac{252}{60}} \quad (3)$$

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volatility for the firm's options,  $\sigma^2$ . Thus, any option pricing model misspecification likely affects  $\sigma^2$  more than  $(\sigma^{EA})^2$ , which is the major portion of total implied announcement volatility,  $IAV$ .

<sup>11</sup> In addition to volatility associated with anticipated changes in equity prices, stocks can be subject to stochastic volatility. To the extent investors anticipate a volatility regime shift at earnings announcements,  $IAV$  could be larger than anticipated announcement volatility and, thus, our announcement risk premiums could be overstated. We adopt the jump-diffusion model because of the substantial prior literature finding a jump in stock prices at earnings announcements. Regardless, our interest is in the relation between announcement risk premiums and non-diversifiable risk, not the magnitude of the premiums.

<sup>12</sup> We base our estimates of  $(\sigma^{EA})^2$  and  $\sigma^2$  on at-the-money options because Whaley (1986) finds that implied volatilities derived from the Black and Scholes (1974) formula are most representative of realized volatility for at-the-money options.

Our estimation of  $(\sigma^{EA})^2$  assumes investors anticipate the announcement of earnings at some point between the date of the option prices we use to estimate equation (3) and the expiration of the options.<sup>13</sup> We then use our estimate of  $(\sigma^{EA})^2$  and equation (1) to estimate  $\sigma^2$ . To reduce measurement error in calculating  $IAV_q$ , in equation (2) we use the averages of  $(\sigma^{EA})^2$  and  $\sigma^2$  over the five days ending two days prior to the announcement date,  $\overline{(\sigma^{EA})^2}$  and  $\overline{\sigma^2}$ .

### 3.2. Validity of implied announcement volatility

We validate our measure of implied announcement volatility,  $IAV$ , by comparing it to realized absolute earnings announcement returns and firm characteristics prior research finds are associated with equity price reactions to earnings announcements. To the extent  $IAV$  captures expected earnings announcement risk, we expect a positive relation between  $IAV$  and realized volatility as well as these firm characteristics. To make the comparison, we sort firm-quarter observations into deciles of implied announcement volatility,  $IAV_q$ . We form deciles each calendar quarter and assign the highest (lowest)  $IAV_q$  observations to decile 10 (1). We test whether the difference in means for our variables of interest between deciles 10 and 1 is significantly different from zero.

The seven characteristics of firm  $i$  associated with earnings announcement risk we consider are:  $|RET|_{i,q}$ , the absolute value of the realized one-day quarter  $q$  earnings announcement return;<sup>14</sup>  $SIZE_{i,q}$ , the natural logarithm of market capitalization;  $LBM_{i,q}$ , the natural logarithm of one plus the equity book-to-market ratio;  $MKTSHR_{i,q}$ , the percent share of two-digit SIC code

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<sup>13</sup> To the extent investors' anticipated earnings announcement date is outside the 30- and 60-day option maturity window, our estimates of implied jump volatility,  $\overline{(\sigma^{EA})^2}$ , and the announcement risk premium are likely to be understated. However, section 5.4.1 reports that our inferences are unaffected by using expected announcement dates as in Cohen, Dey, Lys, and Sunder (2007).

<sup>14</sup> Specifically,  $RET_{i,q}$  equals  $\log(S_{q+}/S_{q-})$  where  $S$  is the firm's stock price, and the subscript  $q+$  ( $q-$ ) indicates the stock price is measured at the closing price the day of (the day prior to) the quarter  $q$  earnings announcement.

industry sales;  $HISTRET_{i,q}$ , the average of the absolute market-adjusted quarterly earnings announcement return over the three years prior to quarter  $q$ ;  $DISP_{i,q}$  the standard deviation of analyst earnings forecasts, scaled by beginning of quarter share price; and  $|FE|_{i,q}$ , the absolute earnings forecast error, i.e., actual earnings per share minus the consensus earnings forecast immediately preceding the earnings announcement, scaled by beginning of the quarter stock price. We expect  $IAV$  is positively related to  $|RET|$ ,  $HISTRET$ ,  $DISP$ , and  $|FE|$ , and negatively related to  $SIZE$ ,  $LBM$ , and  $MKTSHR$ .<sup>15</sup>

We also estimate equations (4) and (5) to compare the relation between implied announcement volatility and the firm characteristics, other than  $|RET|$ , and the relation between realized absolute announcement returns,  $|RET|$ , and the characteristics.

$$IAV_q = \lambda_0 + \lambda_1 SIZE_q + \lambda_2 LBM_q + \lambda_3 MKTSHR_q + \lambda_4 HISTRET_q + \lambda_5 DISP_q + \lambda_6 |FE|_q + \varepsilon_q \quad (4)$$

$$|RET|_q = \gamma_0 + \gamma_1 SIZE_q + \gamma_2 LBM_q + \gamma_3 MKTSHR_q + \gamma_4 HISTRET_q + \gamma_5 DISP_q + \gamma_6 |FE|_q + \varepsilon_q \quad (5)$$

To the extent  $IAV_q$  captures equity volatility associated with quarter  $q$ 's earnings announcement, we expect the coefficients in equations (4) and (5) have the same signs.<sup>16</sup> We do not expect that the coefficient magnitudes are the same in the two equations because  $IAV$  and  $|RET|$  have different units of measure. Whereas  $IAV$  is the standard deviation of the expected distribution of announcement returns,  $|RET|$  is the absolute value of the realized announcement return.

### 3.3. Risk premium proxy

We next use option prices to construct a proxy for risk premiums directly associated with earnings announcement risk. As explained in section 3.1, one reason we use option prices is that

<sup>15</sup> For notational simplicity, henceforth, we drop the  $i$  subscript from all variables.

<sup>16</sup> We use the similar notation for coefficients and error terms in our equations for ease of exposition. In all likelihood, they differ.

doing so permits us to calculate the difference between implied and realized earnings announcement equity volatility. This difference measures the effect of excess earnings announcement volatility on option prices and, thus, provides a basis for developing our proxy for earnings announcement risk premiums.

Purchasers of options have the right, but not the obligation, to exercise the options before they expire. Equity investors commonly purchase options because options act as a form of insurance that limits the risk of equity positions. In contrast, because the exercise of options is at discretion of the option purchaser, options pose risk to option writers associated with whether, and at what price, the option will be exercised. Option prices compensate the writer for bearing this risk. If earnings announcements convey macroeconomic news that increases the volatility of all assets comprising the market portfolio, option writers will demand a risk premium in the form of higher option prices for bearing non-diversifiable earnings announcement risk for options associated with such news. Because, all else equal, the higher the option price the higher is calculated implied volatility, higher risk premiums embedded in option prices manifest as implied volatility that is systematically in excess of realized volatility.

We use excess implied announcement volatility as our proxy for earnings announcement risk premiums, which we calculate for firm-quarter  $q$  as:

$$ExVol_q \equiv 1 - sdev\left(\frac{RET_q}{IAV_q}\right) \equiv 1 - sdev(SAR_q), \quad (6)$$

where  $ExVOL_q$  is the excess volatility reflected in option prices,  $sdev$  denotes standard deviation for each firm over quarter  $q + 1$  to  $q + 10$ , and  $RET_q$  is the firm's realized one-day quarter  $q$  earnings announcement return.  $SAR_q$  is the realized earnings announcement return scaled by the implied standard deviation of earnings announcement returns. We specify  $ExVOL$  as in equation (6) because under the null hypothesis that implied announcement volatility equals realized

announcement volatility,  $SAR_q$  has a standard normal distribution. As a result, if there is no announcement risk premium, i.e., if implied announcement volatility equals realized announcement volatility, then  $sdev(SAR_q)$  equals one and  $ExVOL_q$  equals zero.

Our tests focus on the alternative hypothesis that there is an earnings announcement risk premium to the extent that the announcement risk is non-diversifiable. In such circumstances, we expect implied announcement volatility to systematically exceed realized announcement volatility, i.e., that  $sdev(SAR_q)$  is less than one. Thus, we define  $ExVOL_q$  as one minus  $sdev(SAR_q)$  so that  $ExVOL_q$  is increasing in the magnitude of the risk premium. Larger values of  $ExVOL_q$  correspond to implied announcement volatility that exceeds realized announcement volatility, which indicates that writers of options outstanding at earnings announcements earn a positive expected return for writing the options. We use quarters subsequent to quarter  $q$  to calculate  $ExVOL_q$  because we seek to test whether firm-specific non-diversifiable earnings announcement risk assessed based on past information explains rational expectations of a risk premium associated with future earnings announcements.

### 3.4. Risk premiums and non-diversifiable risk

To address our main research question, we estimate the following equation:

$$ExVOL_q = \alpha_0 + \alpha_1 COMOVE_q + \alpha_2 ANBETA_q + \alpha_3 SAMEDATE_q + \varepsilon_q. \quad (7)$$

The explanatory variables in equation (7) are designed to capture non-diversifiable risk specifically associated with earnings announcements.  $COMOVE$  is designed to capture the idea that earnings announcement risk is non-diversifiable when the announcing firm's earnings news results in parallel price changes for the market portfolio, i.e., the firm's return comoves with the market return. We define comovement on day  $t$  as minus one times the absolute difference between a firm's day  $t$  equity return and the contemporaneous equal-weighted equity market

return,  $MKT_t$ , i.e.,  $COMOVE_t = -|RET_t - MKT_t|$ .<sup>17</sup> To capture non-diversifiable risk directly associated with the earnings announcements, we include in equation (7),  $COMOVE_q$ , which is the difference in a firm's comovement between earnings announcement days,  $COMOVE_{EA}$ , and non-announcement days,  $COMOVE_{NEA}$ . Specifically,

$$\begin{aligned} COMOVE_q &= COMOVE_{EA} - COMOVE_{NEA} \\ &= -|RET_t - MKT_t|^{EA} + |RET_t - MKT_t|^{NEA} \end{aligned} \quad (8)$$

where  $-|RET_t - MKT_t|^{EA}$  is the average comovement on earnings announcement days and  $-|RET_t - MKT_t|^{NEA}$  is the average comovement on non-announcement days, both for the three years prior to the quarter  $q$  earnings announcement. Higher values of  $COMOVE_q$  indicate greater non-diversifiable risk.<sup>18</sup>

$ANBETA$  is the difference between the firm's CAPM beta on earnings announcement days and its CAPM beta during non-announcement periods. Our use of  $ANBETA$  to capture earnings announcement-specific non-diversifiable risk is motivated by the findings in Ball and Kothari (1991) that betas increase around earnings announcements.  $ANBETA$  is designed to capture this increase.  $ANBETA_q$  is  $\beta_3$  from the following firm-specific regression, estimated over the three years prior to the quarter  $q$  earnings announcement:

$$RET_t = \beta_0 + \beta_1 MKT_t + \beta_2 AnnDate_t + \beta_3 MKT_t * AnnDate_t + \varepsilon_t \quad (9)$$

where  $AnnDate_t$  is an indicator variable that equals one on days within the three-day window of a quarterly earnings announcement. Because  $\beta_1$  measures the firm's CAPM beta during non-announcement periods  $ANBETA_q$ , i.e.,  $\beta_3$ , is the increase in beta around the firm's earnings announcements.

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<sup>17</sup> Our inferences are unaffected if, instead, we use the value-weighted market return or the return on the S&P 500.

<sup>18</sup> Our inferences are unaffected if we use announcement period comovement instead of the difference in comovement between announcement and non-announcement periods.

$SAMEDATE_q$  is the natural logarithm of the number of firms in the Compustat database that in quarter  $q - 1$  had the same earnings announcement date as the firm.  $SAMEDATE$  measures the extent of aggregate earnings news conveyed to the market on the day the firm announces earnings and, hence, higher values correspond to greater non-diversifiable risk. This is because the greater is the number of other firms announcing earnings on the day the firm announces its earnings, the less likely it is that investors can diversify the news conveyed by the firm's announcement.

Because  $COMOVE$ ,  $ANBETA$ , and  $SAMEDATE$  are constructed so that higher values indicate greater non-diversifiable risk, we predict  $\alpha_1$ ,  $\alpha_2$ , and  $\alpha_3$  are positive. We estimate equation (7) based on firm-quarter observations. Because we estimate  $ExVOL$  using information from the firm's next ten quarterly earnings announcements,  $ExVOL$  is likely correlated over time. Thus, we base the  $t$ -statistics associated with coefficient estimates from equation (7) on regression residuals clustered by firm and quarter (Gow, Ormazabal, and Taylor, 2010).

## **4. Sample, Data, and Descriptive Statistics**

### *4.1. Sample and data*

Our analyses require option data, which we obtain from OptionMetrics. OptionMetrics contains end-of-day summary information on all Chicago Board Options Exchange listed options on US equities beginning in 1996. Our sample comprises all firms on OptionMetrics that meet our sample selection criteria with data available to construct our variables. For each firm and day, OptionMetrics calculates implied volatility for standardized 30- and 60-day call options, which can be thought of as the implied volatility of at-the-money options of constant duration (Rogers, Skinner, and Van Buskirk, 2009). We use standardized implied volatility to mitigate



concerns associated with estimating implied volatility from multiple near-the-money options with varying expiration dates.

Our tests use one-day earnings announcement returns. However, several studies note that some Compustat earnings announcement dates are incorrect, and using an incorrect earnings announcement date reduces the power of and can bias our tests. Thus, to identify earnings announcement dates, we follow Dellavigna and Pollet (2009) and compare I/B/E/S and Compustat announcement dates and assume that the earlier date is the announcement date. Dellavigna and Pollet (2009) compares this assumed date with the newswire time stamp and reports that the assumed date is correct more than 95% of the time. In addition, we use the I/B/E/S time stamp to determine whether the announcement occurred after the market close. When the announcement occurs after the market close, we adjust the announcement date one trading day forward.<sup>19</sup>

We obtain accounting data from Compustat, and daily equity returns, the equal-weighted market return, and data to construct betas from CRSP. We require firms to have earnings announcement dates on I/B/E/S, and require three years (ten quarters) of data prior (subsequent) to each quarterly observation to construct our variables.<sup>20</sup> Applying our sample selection criteria results in a sample of 45,181 firm-quarter observations for 2,576 firms from 1996 to 2007.

#### *4.2. Descriptive statistics*

Table 1 presents descriptive statistics for the variables we use in our analyses. Panel A presents distributional statistics and reveals that the mean of  $IAV$ , implied announcement

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<sup>19</sup> See section 5.4.1 for a discussion of the robustness of our inferences to using alternative approaches to identify announcement dates.

<sup>20</sup> This data requirement potentially introduces survivorship bias into our sample. We expect that larger, surviving firms have greater non-diversifiable earnings announcement risk, and thus larger announcement risk premiums. However, although survivorship bias could affect the magnitude of the announcement risk premium, our interest is in the relation between the risk premium and non-diversifiable risk, not the magnitude of the premium.

volatility, is 0.064. Consistent with option traders expecting increases in equity volatility at earnings announcements, untabulated statistics reveal that the ratio of  $(\sigma^{EA})^2$  to  $IIV$  is 0.643, which indicates that almost two-thirds of implied announcement volatility is attributable to anticipated price changes directly associated with the announcement, rather than with baseline diffusive volatility of the announcing firm. The statistics also reveal that  $(\sigma^{EA})^2$  explains 76% of the variation in  $IIV$ . More importantly for our research question, panel A also reveals that the mean of  $ExVOL$  is 0.149. A positive mean  $ExVOL$  is consistent with an earnings announcement risk premium embedded in option prices. Untabulated statistics reveal that this mean is significantly different from zero (bootstrap  $t$ -statistic = 13.54).

Regarding our measures of non-diversifiable earnings announcement risk, panel A reveals that the mean of  $COMOVE$  is  $-0.011$ , which indicates that, on average, the comovement of firm' returns is greater at earnings announcements than during non-earnings announcement periods. The mean of  $ANBETA$ , the percentage difference between beta at earnings announcements and beta in non-announcement periods, is 0.113. This positive mean for  $ANBETA$  is consistent with an increase in beta at earnings announcements as documented in prior research, and with the estimates in Hsieh, Jerris, and Ross (1999). The mean of  $SAMEDATE$  of 5.283 indicates that, on average, approximately 200 sample firms announce earnings on the same date. Panel A of table 1 also reveals that the means of  $|RET|$ , 4.567, and  $HISTRET$ , 4.460, indicate that firms experience large price changes at earnings announcements, and the mean of  $|FE|$ , 0.002, indicates that, on average, there is earnings news. Means of the other variables provide perspective on the types of firms included in the sample.

Panel B of table 1 presents correlations between the variables; all correlations greater than 0.01 in absolute value are significantly different from zero.<sup>21</sup> Regarding excess implied volatility, our proxy for the earnings announcement risk premium, panel B reveals that *ExVOL* is negatively correlated with *IAV* (Pearson =  $-0.07$ ; Spearman =  $-0.06$ ). More importantly for our research question, panel B reveals that, as expected, *ExVOL* is positively correlated with our proxies for non-diversifiable earnings announcement risk, *COMOVE* and *SAMEDATE* (Pearson = 0.34 and 0.03; Spearman = 0.39 and 0.03). Contrary to expectations, *ExVOL* is negatively correlated with *ANBETA* (Pearson and Spearman =  $-0.01$ ), although not significantly so.

## 5. Findings: Announcement Risk Premiums

### 5.1. Implied announcement volatility and earnings announcement risk

Table 2 presents means of various firm characteristics across deciles of implied announcement volatility, *IAV*. Table 2 reveals that firms with higher *IAV* have significantly larger absolute realized announcement returns,  $|RET|$  (High – Low = 2.341), which indicates that expected announcement volatility reflected in option prices generally is realized. Table 2 also reveals that firms with higher *IAV* have larger earnings forecast errors,  $|FE|$ , are smaller, *SIZE*, and have smaller equity book-to-market ratios, *LBM*, smaller market share, *MKTSHR*, and larger absolute past announcement returns, *HISTRET*. All of these differences are significant, with *p*-values ranging from 0.017 to 0.000. Although firms with larger *IAV* have greater dispersion of analyst forecasts, *DISP*, the difference is not significant (*p*-value = 0.206). These differences in firm characteristics are consistent with implied announcement volatility being larger for firms with poor information environments.

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<sup>21</sup> We use the term significant to denote statistical significance at the 5% percent level based on a one-sided test when we have a signed prediction, and a two-sided test otherwise.

Table 3 presents summary statistics from estimation of several versions of equation (4), in panel A, and equation (5), in panel B. The versions differ by which of the firm characteristics in table 2 are included as explanatory variables. Panel A reveals that the significant relations between *IAV* and firm characteristics presented in table 2 reflect different dimensions of earnings announcement risk. That is, the coefficients on *SIZE*, *LBM*, *MKTSHR*, *HISTRET*, and  $|FE|$ , all are significantly different from zero (*t*-stats. range from 2.81 to 12.63 in absolute value) regardless of whether the characteristics are considered alone, or incremental to the other characteristics. In addition, table 3, panel A, reveals that *DISP* is significantly positively related to *IAV*, after including other variables in the equation (*t*-stats. = 3.04 and 2.07 in Columns 4 and 5), whereas the univariate correlation in table 2 is not significantly different from zero. This finding suggests that analyst forecast dispersion also is a proxy for earnings announcement risk, likely reflecting uncertainty about future cash flows.

Supporting our interpretation of *IAV* as a proxy for earnings announcement risk, panel B of table 3 reveals, as expected, that the signs of the relations between the absolute value of the realized price change at earnings announcements,  $|RET|$ , and firm characteristics are the same as they are in panel A. The only exception is that the relation between  $|RET|$  and analyst earnings forecast dispersion, *DISP*, is not significant in Column 4, but is significantly negative in Column 5, after including  $|FE|$  (*t*-stats. = 0.96 and  $-2.21$  in Columns 4 and 5). As is the case in panel A for implied announcement volatility,  $|RET|$  is significantly negatively related to firm size, *SIZE*, the equity book-to-market ratio, *LBM*, and industry market share, *MKTSHR*, and significantly positively related to the absolute value of past earnings announcement returns, *HISTRET*, and the absolute value of earnings forecast errors,  $|FE|$ .

The findings in tables 2 and 3 support using announcement volatility implied by option prices as a proxy for expected earnings announcement risk, and for interpreting systematic differences between implied and realized announcement volatility as evidence of risk premiums reflected in option prices.

### 5.2. Non-diversifiable announcement risk and risk premiums

Table 4 presents summary statistics from estimating several versions of equation (7). The versions differ by which non-diversifiable risk measures are included as explanatory variables. Column 1 presents statistics relating to equation (7) with only *COMOVE* as an explanatory variable. As expected, Column 1 reveals that the coefficient on *COMOVE* is positive and significantly different from zero ( $t$ -stat. = 22.17), and that *COMOVE* explains 10.4% of the variation in the excess implied announcement volatility, *ExVOL* ( $\text{adj. } R^2 = 0.104$ ). This significant positive relation indicates that earnings announcement risk premiums are significantly higher when the firm's quarterly earnings announcement return comoves more with the market return on the firm's earnings announcement day, i.e., when the firm's earnings announcement reflects more non-diversifiable risk.<sup>22</sup>

The second (third) column reveals that the increase in the firm's CAPM beta during earnings announcements, *ANBETA* (the number of firms that have the same earnings announcement date as the firm, *SAMEDATE*) is insignificantly negative (significantly positive), with a  $t$ -statistic of  $-1.06$  (3.53). The fourth column of table 4 reveals that these three measures reflect different dimensions of non-diversifiable earnings announcement risk in that each

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<sup>22</sup> *COMOVE* is based on the market index for the US. To investigate whether our findings extend to global market non-diversifiable earnings announcement risk, we redefined *COMOVE* using as the market index the Dow Jones STOXX Global 1800 Index. Our sample firms are in the US and by the time they announce earnings, it could be the following day in elsewhere in the world. Thus, we use a two-day return on the Dow Jones STOXX Global 1800 Index—the day of and the day after the earnings announcement. Untabulated findings from estimating all versions of equation (7) with this redefined *COMOVE* variable reveal inferences identical to those we tabulate.

measure has significant incremental explanatory power for *ExVOL*. The coefficients on all three non-diversifiable risk measures are significantly positive ( $t$ -stats. = 22.16, 2.16, and 3.84). That *ANBETA* is significantly positive related to *ExVOL* in Column 4 suggests that including *COMOVE* and *SAMEDATE* in the estimation equation removes some of the measurement error associated with the relation between risk premiums and *ANBETA*.

The findings in table 4 indicate that excess implied announcement volatility is higher when earnings announcement risk is non-diversifiable. This indicates that excess implied volatility reflects a risk premium embedded in option prices that is associated with non-diversifiable earnings announcement risk.

#### 5.4. Additional Analyses

##### 5.4.1. Earnings announcement dates

Incorrectly specifying the actual or expected earnings announcement date could confound our inferences because both affect our proxy for announcement risk premiums, *ExVOL*. The earnings announcement date affects the numerator of the scaled announcement return,  $SAR_q$ , in equation (6) because that is the date on which we measure the firm's announcement stock return. It also affects the denominator of  $SAR_q$  because our tests treat the actual announcement date as the announcement date expected by option traders. This section describes findings based on alternative approaches to identifying the actual and expected earnings announcement dates and reports that our inferences are not affected by using these alternatives.

First, Cohen, Dey, Lys, and Sunder (CDLS, 2007) develop a procedure to identify Early, On-time, and Late earnings announcements. We implement the CDLS procedure to estimate a firm's expected earnings announcement date and use that date to calculate *ExVOL*. In particular, we analyze the distributions of each firm's earnings announcement dates for each fiscal quarter

during the sample period. For each firm-quarter, we identify the firm's announcement date as one of 63 days in the quarter, i.e., day 1 through day 63. We divide our sample into two six-year subperiods and use the median announcement date within each subperiod as the expected announcement date. We identify an earnings announcement as "On-time" if it occurs within one day of the expected date, as "Early" if it occurs before that date, and as "Late" if it occurs after that date. Availability of option data results in a somewhat smaller sample size than in our primary tests.

Table 5 presents findings for the full sample and for Early, On-time, and Late announcements. As in CDLS, table 5 reveals that although the adjusted  $R^2$ s in table 5 are noticeably smaller than those in table 4 (adj.  $R^2$ s range from 0.031 to 0.046 in table 5 versus 0.106 in table 4), our inferences are unaffected by the timing of the actual announcement relative to the expected date. In particular, the coefficients on *COMOVE*, *ANBETA*, and *SAMEDATE* are positive in all four columns and significantly so, except for those on *SAMEDATE* for Early and Late announcements and *ANBETA* for Late announcements. The difference in results for late announcing firms is consistent with investors inferring the content of earnings news when the announcement is delayed. The  $t$ -statistics for the coefficients on *COMOVE* range from 9.14 to 14.13, those for *ANBETA* range from 1.18 to 2.50, and those for *SAMEDATE* range from 1.58 to 2.65.

Second, incorrectly identifying the actual announcement date could inflate our measure of *ExVOL* because the numerator of  $SAR_q$  in equation (6) will be understated. However, the findings in table 4 reveal that announcement risk premiums are larger for firms with more non-diversifiable earnings announcement risk, which tend to be larger firms whose earnings announcement dates are more likely to be correctly identified. Nonetheless, we alternatively

treat as the announcement date the day with the firm's largest absolute return between day  $t - 5$  and  $t + 5$ , where day  $t$  is the announcement date. The untabulated findings reveal that our inferences are unaffected by using this alternative announcement date.

Third, in our primary tests, we calculate the numerator of  $SAR_q$  using one-day earnings announcement returns because prior research establishes that earnings news is reflected in prices within minutes of the earnings announcement. However, findings based on returns over longer windows that include the announcement return also should be consistent with our expectations. Although longer return window tests likely suffer from reduced power, using longer return windows helps ensure that the numerator of  $SAR_q$  includes the announcement return. Thus, we re-estimate equation (7) alternatively using measures of  $ExVOL$  based on three-day and seven-day returns, i.e., returns from days  $t - 1$  to  $t + 1$  and days  $t - 3$  to  $t + 3$  relative to the announcement date. The untabulated findings reveal that our inferences are unaffected by using these alternative measures of  $ExVOL$ .

Fourth, CDLS estimates a firm's expected earnings announcement date and finds that 87% of actual announcements occur within the 11-day window surrounding the expected announcement date. Thus, we recalculate the denominator of  $SAR_q$  using option prices from day  $t - 10$  to day  $t - 6$ , which avoids using option prices that reflect the realizations of early earnings announcements, and re-estimate equation (7). The untabulated findings reveal inferences consistent with those revealed by table 4. In particular, the untabulated coefficients on  $COMOVE$ ,  $ANBETA$ , and  $SAMEDATE$  are all significantly positive.

Finally, we investigate whether the relation between our measures of non-diversifiable earnings announcement risk are associated with risk premiums during non-announcement periods. Our hypotheses and tests are predicated on the idea that earnings announcements are a



source of non-diversifiable risk because firm's earnings news conveys information regarding market-wide asset returns. Thus, in the absence of earnings news, we do not expect to observe a positive relation between our non-diversifiable risk measures and excess implied volatility.

To test this prediction, we generate pseudo earnings announcement dates by subtracting a randomly selected number of trading days from the actual announcement date and re-estimating equation (7). For example, if the random number for a firm is 40, we set the firm's pseudo earnings announcement date to 40 trading days prior to the firm's actual announcement date. The random numbers are from a uniform distribution spanning 30 to 50. We use 30 to 50 as the support of the distribution to ensure many days of separation between the pseudo and actual announcement dates. We re-estimate *ExVOL* and equation (7) based on the pseudo announcement dates. The untabulated findings reveal no evidence of a significant positive relation between our non-diversifiable announcement risk measures and excess implied volatility reflected in option prices. These findings support our premise that earnings news is crucial to documenting a relation between risk premiums reflected in option prices, manifested by excess implied volatility, and non-diversifiable earnings announcement risk.

#### *5.4.2. Sign of earnings news and management guidance*

Our primary tests assume that the news in earnings is released at the earnings announcement. However, some firms pre-announce bad news, some firms delay the announcement of bad news, the market reaction to good and bad news differs (e.g., Givoly and Palmon, 1982; Chambers and Penman, 1984; Skinner, 1994; Kothari, Shu, and Wysocki, 2009), and some firms give guidance prior to the earnings announcement (Penman, 1980; Kasznik and Lev, 1995; Skinner, 1997; and Rogers, Skinner, and Van Buskirk, 2009). In addition, prior

research finds differences in announcement equity returns for larger and smaller firms. Thus, we determine whether our inferences apply to these subsamples of firms and announcements.

Table 6, panel A, presents findings from equation (7) for announcements with Good and Bad earnings news, where Good and Bad news are based on whether the firm's announced earnings is above or below the consensus analyst earnings forecast just prior to the earnings announcement. Panel A reveals that our inferences relating to the association between non-diversifiable earnings announcement risk and announcement risk premiums apply to both Good News and Bad News earnings announcements. In particular, the coefficients on *COMOVE* and *SAMEDATE* are both significantly positive for both groups of announcements, and that on *ANBETA* is significantly positive for Bad News announcements. For Good News announcements the *t*-statistics for *COMOVE*, *ANBETA*, and *SAMEDATE* are 22.93, 1.58, and 3.27; for Bad News announcements, they are 15.04, 2.68, and 3.90. The intercept in Column 2 is significantly larger than that in Column 1 indicating that announcement risk premiums are larger for negative earnings news. This finding is consistent with Anilowski, Feng, and Skinner (2007), which finds that firms' earnings guidance is more likely to elicit a parallel shift in market prices when the guidance is negative.

Table 6, panel B, presents analogous findings for earnings announcements partitioned by whether the firm provided management guidance for that quarter prior to the earnings announcement window, i.e., an earnings forecast reported in the First Call Company Issued Guidelines database within 60-trading days before the announcement date. As in panel A, panel B reveals that the coefficients on all three non-diversifiable announcement risk measures are significantly positive for both types of announcements, except for that on *ANBETA* for the No Guidance announcements. For the Guidance announcements, the *t*-statistics for the coefficients

on *COMOVE*, *ANBETA*, and *SAMEDATE* are 15.67, 2.21, and 3.99; for the No Guidance announcements, they are 21.54, 1.57, and 2.77. The intercept in Column 2 is significantly larger than that in Column 1, which is consistent with announcement risk premiums being larger when firms do not preempt earnings news with management guidance.

Table 6, panel C, presents analogous findings for earnings announcements by firms with market capitalization above (below) the annual sample median, i.e., Larger (Smaller) Firms. Panel C reveals that the coefficients on *COMOVE*, *ANBETA*, and *SAMEDATE* are significantly positive for Larger Firms ( $t$ -stats. = 18.36, 1.91, and 5.52). The coefficient for Smaller Firms is significantly positive for *COMOVE* ( $t$ -stat. = 13.85), but not for *ANBETA* or *SAMEDATE*. Panel C also reveals that the intercept is significantly larger for Larger Firms, 0.228 versus 0.055. The findings in panel C indicate that the findings in table 4 largely are attributable to larger firms, which is consistent with larger firms posing greater non-diversifiable risk.

### 5.3. *Alternative proxies for Non-Diversifiable Announcement Risk*

We interpret our findings thus far as suggesting that earnings announcements are a mechanism through which macroeconomic news is conveyed to investors. In this section, and in section 6, we provide additional evidence supporting this interpretation. Throughout our analysis, we interpret excess implied announcement volatility as reflecting a risk premium embedded in option prices. One concern about our interpretation is that excess implied announcement volatility could reflect option mispricing rather than compensation for non-diversifiable risk. This section attempts to mitigate this concern by examining equation (7) after including three additional proxies for non-diversifiable announcement risk.

We estimate the following version of equation (7).

$$ExVOL_q = \alpha_0 + \alpha_1 SIZE_q + \alpha_2 Bellwether_q$$

$$\begin{aligned}
& + \alpha_3 EFAC_q + \alpha_4 HISTRET_q + \alpha_5 EFAC * HISTRET_q & (10) \\
& + \alpha_6 COMOVE_q + \alpha_7 ANBETA_q + \alpha_8 SAMEDATE_q + \varepsilon_q
\end{aligned}$$

As with equation (8), we estimate equation (10) based on firm-quarter observations.

We include *SIZE* in equation (10) because the findings in table 6, panel C, suggest that size is an alternative proxy for non-diversifiable earnings announcement risk, which is consistent with the finding in Anilowski, Feng, and Skinner (2007) that market returns move in the direction of managerial guidance from larger firms. Intuitively, larger firms represent a larger fraction of the market and thus their earnings are more likely to be informative of market-wide asset returns than earnings of smaller firms. *BellWether* is an indicator variable that equals one if the firm is an industry leader and the firm's industry is a major sector, and zero otherwise. These are the firms in the highest decile of industry sales for the five two-digit SIC code industries with the largest sales. We include *Bellwether* in equation (10) because we expect earnings news of leaders of industries that represent a major sector of the economy to serve as a bellwether for macroeconomic trends.

Equation (10) also includes *EFAC*, which captures aggregate earnings factors. Beginning with Ball and Brown (1968), research documents that earnings of firms in the economy move together. More recently, Ball, Sadka, and Sadka (2009) demonstrates that a substantial portion of firm-level earnings can be explained by common earnings factors, which implies that earnings shocks have substantial systematic components. We build upon Ball, Sadka, and Sadka (2009) by showing that investors price options as if some earnings announcements represent non-diversifiable information shocks. In particular, we show that option prices reflect a risk premium that varies cross-sectionally with the extent to which the price reactions to a firm's past earnings announcements are non-diversifiable. *EFAC* is the  $R^2$  from a firm-specific regression of a firm's return-on-assets on the first five principal components of aggregate earnings factors. We

estimate the regressions using data from the ten years prior to quarter  $q$ , i.e., from quarter  $q - 40$  to  $q - 1$ . We calculate the aggregate earnings factors based on the Ball, Sadka, and Sadka (2009) methodology, but modified to our setting. Specifically, in each calendar year, we extract the first five principal components of return-on-assets for the 500 largest firms based on market capitalization.

We have no prediction for the sign of the coefficient on  $EFAC$ , the firm's sensitivity to the aggregate earnings factor.  $EFAC$  could be positively associated with  $ExVOL$  if higher sensitivities to aggregate earnings indicate the earnings contains more macroeconomic news. However,  $EFAC$  could be negatively associated with  $ExVOL$  if the higher sensitivities indicate more predictable earnings and, thus, less risk at the earnings announcement. For example, higher sensitivities to the aggregate earnings factor may indicate that the market is able to infer the firm's earnings from earnings announced by other firms. We also have no prediction for the sign of the coefficient on  $HISTRET$ . This is because although we expect past earnings announcement news to be positively associated with risk, such news might be diversifiable and, thus, not related to the announcement risk premium. That is, we expect earnings announcements that are more sensitive to aggregate earnings and convey more news are associated with larger announcement risk premiums. Thus, the focus of our tests is the coefficient on  $EFAC * HISTRET$ , i.e., the interaction between  $EFAC$  and  $HISTRET$ . We predict  $\alpha_5$  is positive.

Table 7 presents summary statistics from estimating several versions of equation (10). Columns 1 and 2 present summary statistics relating to versions that include  $SIZE$  and  $Bellwether$ , in addition to our three earnings announcement non-diversifiable risk measures,  $COMOVE$ ,  $ANBETA$ , and  $SAMEDATE$ . Column 1 reveals, as expected, that  $SIZE$  is significantly positively associated with  $ExVOL$  ( $t$ -stat. = 14.19), and Column 2 reveals that  $ExVOL$  is

significantly larger for *Bellwether* firms ( $t$ -stat. = 8.98).<sup>23</sup> These findings indicate that excess implied announcement volatility is higher for large firms and industry leaders, incremental to our announcement-specific measures of non-diversifiable risk.

Column 3 presents statistics from estimating a version of equation (10) that includes *EFAC*, *HISTRET*, and *EFAC\*HISTRET* in addition to our non-diversifiable earnings announcement risk measures. The coefficient on *EFAC* is significantly negative ( $t$ -stat. = -3.96), which indicates that the greater the sensitivity to aggregate earnings factors, the smaller the announcement risk premium. We also find that the coefficient on *HISTRET* is significantly negative ( $t$ -stat. = -13.46), which indicates that more news at prior earnings announcements is associated with lower risk premiums. More importantly, and as expected, the coefficient on *EFAC\*HISTRET* is significantly positive ( $t$ -stat. = 2.24). This finding indicates that earnings announcement risk premiums are larger when the announced earnings is more sensitive to aggregate earnings factors and conveys more news to the market.

Column 4 reveals that *SIZE*, *Bellwether*, and *EFAC\*HISTRET* are all significantly related to *ExVOL*, incremental to each other and to *COMOVE*, *ANBETA*, and *SAMEDATE* ( $t$ -stats. = 10.37, 2.82, and 2.01). In Columns 1 through 4, consistent with table 4, the coefficients on *COMOVE* and *SAMEDATE* are significantly positive ( $t$ -stats. range from 3.98 to 23.00), and that on *ANBETA* is positive but only significantly so in Column 2 ( $t$ -stats. range from 0.81 to 1.98). Column 5 presents statistics from a version of equation (10) that omits our non-diversifiable earnings announcement risk measures and reveals inferences that are the same as revealed by the other four columns.

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<sup>23</sup> To ensure that *Bellwether* is not simply a non-linear measure of firm size, we also include the square of firm size as a control variable. Untabulated findings reveal that the inclusion of squared size does not noticeably affect the relation between *Bellwether* and *ExVOL*.

## 6. Marketwide News and Non-diversifiable Earnings Announcement Risk

Our findings suggest that earnings announcements can convey information about the broader economy and that expectations of non-diversifiable earnings news are reflected in option prices prior to the announcements. If this interpretation is valid, then one would predict that the expected correlation of returns for firms comprising the S&P500 index is positively related to the amount of expected non-diversifiable earnings news.

To test this prediction, we estimate equation (11).

$$IMPCORR_m = \alpha_0 + \alpha_1 \overline{COMOVE}_m + \alpha_2 IMPCORR_{m-1} + \varepsilon_m \quad (11)$$

$IMPCORR_m$  is the average correlation between the returns of the firms in the S&P500 index implied by their traded options for month  $m$ , and  $\overline{COMOVE}_m$  is the mean of  $COMOVE$  for firms announcing earnings in month  $m$ .<sup>24</sup> We focus these tests on  $COMOVE$  because of our three non-diversifiable earnings announcement risk measures,  $COMOVE$  evidences the strongest relation to  $ExVOL$  in table 4.

To estimate the average expected correlation among the index components, we follow Driessen, Maenhout, and Vilkov (2009) and assume the correlation between the returns for any pair of firms in the index on a particular day is equal to a constant  $\rho$ , which we seek to estimate. For a generic portfolio consisting of  $n$  firms, the variance of the portfolio return is:

$$\sigma_A^2 = \sum_{i=1}^n a_i^2 \sigma_i^2 + \rho \left( \sum_{i=1}^n \sum_{j=1}^n a_i a_j \sigma_i \sigma_j - \sum_{i=1}^n a_i^2 \sigma_i^2 \right) \quad (12)$$

where  $a_i$  is the portfolio weight assigned to firm  $i$ ,  $\sigma_i^2$  is the expected variance of returns for firm  $i$ , and  $\rho$  denotes our estimate of the average pairwise correlation between the returns of firms  $i$  and  $j$ , for  $j \neq i$ . Based on equation (12), the average expected correlation is:

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<sup>24</sup> Using instead the median of  $COMOVE$  for firms announcing earnings in month  $m$  yields the same inferences.

$$\rho = \frac{\sigma_A^2 - \sum_{i=1}^n a_i^2 \sigma_i^2}{\sum_{i,j} (a_i a_j \sigma_i \sigma_j) - \sum_{i=1}^n a_i^2 \sigma_i^2}. \quad (13)$$

We use equation (13) to estimate *IMPCORR*, our estimate of the implied correlation  $\rho$ , where  $\sigma_A^2$  is the squared value of the VIX, the  $a_i$ s are the portfolio weights derived from total shares outstanding for each firm in the S&P500 index, and  $\sigma_i^2$  is the standardized 30-day implied volatility for firm  $i$  obtained from OptionMetrics. We calculate *IMPCORR* as of the last trading day of each calendar month, for the 137 months from 1996 through 2007, which gives us a monthly time series of estimated expected correlations. *IMPCORR* calculated as of the end of month  $m - 1$  reflects the average expected correlation between the month  $m$  returns of the firms in the S&P500 index. Higher (lower) values of *IMPCORR* correspond to a higher (lower) expected correlation over the next month.

Table 8, panel A, presents the means of *IMPCORR* by quintile of  $\overline{COMOVE}$  across the 137 sample months. As predicted, panel A reveals that higher values of  $\overline{COMOVE}$  correspond to higher average values of *IMPCORR*. In particular, for the months in highest (lowest) quintile of  $\overline{COMOVE}$ , the mean of *IMPCORR* is 0.463 (0.314); the difference of 0.149 is significant ( $p$ -value  $< 0.001$ ). Table 8, panel B, presents regression summary statistics from equation (9). Column 1 confirms the findings in panel A in that the coefficient on  $\overline{COMOVE}$  is positive, as predicted, and significantly different from zero ( $t$ -stat. = 4.41). Panel B also reveals that the average  $\overline{COMOVE}$  for firms announcing earnings in the following month explains 15% of the variation in *IMPCORR*, the implied expected correlation for that following month. Column 2 reveals that  $\overline{COMOVE}$  is significantly positively related to *IMPCORR* incremental to month



indicator variables ( $t$ -stat. = 4.88). The findings in table 8 are consistent with the market anticipating a higher correlation between the components of the S&P500 index when there is greater non-diversifiable earnings announcement risk.

## 7. Conclusion

The question we address is whether non-diversifiable earnings announcement risk is associated with risk premiums. We find cross-sectional variation in the extent to which firms' earnings announcements pose non-diversifiable risk, and provide direct evidence that non-diversifiable earnings announcement risk commands a risk premium embedded in prices of firms' traded options.

To address our research question, we build on prior literature to obtain measures of earnings announcement risk and earnings announcement risk premiums, and develop measures of non-diversifiable earnings announcement risk for a large sample of quarterly earnings announcements by firms with publicly traded equity and traded options. Regarding earnings announcement risk, we extract from prices of a firm's traded options an *ex ante* direct measure of equity volatility investors expect at the firm's earnings announcement, i.e., implied announcement volatility. The greater is implied announcement volatility, the greater is earnings announcement risk. Our measure is based on prior research, including recent advances in option pricing, that specifies expected earnings announcement volatility as a mixture of a firm's expected baseline volatility and an increase in expected volatility associated with the earnings announcement. We validate our measure by showing that implied announcement volatility is significantly positively associated with realized announcement volatility and firm characteristics prior research finds are associated with equity price reactions to earnings announcements. Regarding earnings announcement risk premiums, we compare implied and realized

announcement volatility to estimate risk premiums associated with earnings announcements that are embedded in option prices. Excess implied announcement volatility reflects a risk premium embedded in option prices because the excess volatility reveals that option writers demand higher option prices than would be justified by realized equity volatility alone.

We develop three measures of non-diversifiable earnings announcement risk: the comovement of the firm's equity return and the market return at the firm's prior earnings announcements, the increase in the firm's historical quarterly earnings announcement CAPM beta relative to non-earnings announcement periods, and the number of firms with the same earnings announcement date as the announcing firm. We find that earnings announcement risk premiums are significantly positively associated with all three earnings announcement non-diversifiable risk measures. Our findings are strongest for the measure that captures the extent to which the firm's earnings announcement equity return in the past comoves with market return on the firm's earnings announcement day. Our inferences are robust to using alternative approaches to determine the earnings announcement date, and apply regardless of whether earnings announcements convey good or bad news, the firm issues management earnings guidance prior to the announcement, and the firm is larger or smaller.

Findings from additional analyses support the inference that earnings announcements are a mechanism through which macroeconomic news is conveyed to investors. First, we find that excess implied announcement volatility is larger for larger firms and industry leaders, incremental to our announcement-specific measures of non-diversifiable risk. Second, we find that earnings announcement risk premiums are significantly larger when the announced earnings is both more sensitive to aggregate earnings factors and conveys more news to the market. Third, we find that option prices of the S&P500 index firms reflect a higher expected correlation

between equity returns for these firms for months in which firms with greater non-diversifiable earnings announcement risk announce earnings.

Taken together, our findings establish a significant positive relation between risk premiums and non-diversifiable earnings announcement risk.

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## Appendix A: Variable Definitions

- $ANBETA_q$  is the increase in the firm's beta during earnings announcements relative to non-announcement periods, calculated as  $\beta_3$  from the following firm-specific regression estimated over the three-years prior to the earnings announcement:

$$RET_t = \beta_0 + \beta_1 MKT_t + \beta_2 AnnDate_t + \beta_3 MKT_t * AnnDate_t + \varepsilon_t$$

where  $RET_t$  is the return on day  $t$ ,  $MKT_t$  is the value-weighted market return, and  $AnnDate_t$  is an indicator variable that equals one on days within the three-day window of quarterly earnings announcements, and zero otherwise.

- $Bellwether$  is an indicator variable that equals one when the announcing firm is an industry leader and the firm's industry is a major sector, and zero otherwise. These firms are the firms in the highest decile of industry sales for the five two-digit SIC code industries with the largest sales.
- $COMOVE_q$  equals the change in comovement during earnings announcements relative to non-announcement periods over the three years prior to the quarter  $q$  earnings. More specifically,

$$COMOVE_q = -|RET_t - MKT_t|^{EA} + |RET_t - MKT_t|^{NEA},$$

where  $-|RET_t - MKT_t|^{EA}$  measures the average comovement on earnings announcement dates that occur within the three years prior to quarter. Similarly,  $-|RET_t - MKT_t|^{NEA}$  measures comovement during non-announcement periods over the prior three years.

- $EFAC_q$  is the  $R^2$  from a firm-specific regression of a firm's return-on-assets on the first five principal components of aggregate earnings factors. We estimate the regressions using data from quarter  $q - 40$  to  $q - 1$ . We calculate aggregate earnings factors following the Ball, Sadka, and Sadka (2009) methodology, but modified to our setting. Specifically, in each calendar year, we extract the first five principal components of return-on-assets for the 500 largest firms in Compustat based on market capitalization.
- $ExVOL_q \equiv 1 - sdev(SAR_q)$  is excess implied announcement volatility, where  $sdev$  denotes standard deviation and  $SAR_q$  is calculated for quarter  $q + 1$  to  $q + 10$ , as

$$SAR_q \equiv \left( \frac{RET_q}{IAV_q} \right) \equiv \frac{\log(S_{q+} / S_{q-})}{\sqrt{(\sigma^Q)^2 + \sigma^2 / 252}}.$$

The numerator,  $\log(S_{q+} / S_{q-})$ , is the one-day earnings announcement return and the denominator,  $IAV_q$ , is the *ex ante* implied standard deviation of the announcement return distribution obtained from option prices.

- $|FE|_q$  is the absolute value of the quarter  $q$  earnings forecast error,  $FE_q$ , which is actual earnings per share minus the consensus earnings forecast immediately preceding the earnings announcement, scaled by beginning of the quarter stock price.
- $DISP_q$  is the dispersion in analysts' earnings forecasts immediately prior to the quarter  $q$  earnings announcement, scaled by beginning of the quarter stock price.
- $HISTRET_q$  is the average of the firm's absolute market-adjusted quarterly earnings announcement return, over the three years prior to quarter  $q$ .
- $IAV_q$  is the implied announcement volatility calculated as

$$IAV_q = \sqrt{(\sigma^{EA})^2 + \sigma^2 / 252}$$

where  $\sigma^2$  is implied diffusive volatility expressed in annualized units and  $(\sigma^{EA})^2$  is implied volatility associated with the earnings announcement day. We calculate  $IAV_q$  over the five trading days from  $t - 6$  to  $t - 2$ , where  $t$  is the quarterly earnings announcement date.

- $IMPCORR_m$  is the average correlation between the returns of the firms in the S&P500 index implied by their traded options for month  $m$ . Following Driessen, Maenhout, and Vilkov (2009),

$$IMPCORR_m \equiv \rho = \frac{\sigma_A^2 - \sum_{i=1}^n a_i^2 \sigma_i^2}{\sum_{i,j} (a_i a_j \sigma_i \sigma_j) - \sum_{i=1}^n a_i^2 \sigma_i^2}$$

where  $\sigma_A^2$  is the squared value of the VIX, the  $a_i$ s are the portfolio weights derived from total shares outstanding for each firm in the S&P500 index, and  $\sigma_i^2$  is the standardized 30-day implied volatility for firm  $i$  obtained from OptionMetrics. We calculate  $IMPCORR$  as of the last trading day of each calendar month.

- $LBM_q$  is the log of one plus the firm's equity book-to-market ratio at the end of quarter  $q - 1$ .
- $MKTSHR_q$  is a firm's market share of industry sales measured at the end of quarter  $q - 1$ , where industries are based on two-digit SIC codes.
- $|RET_q|$  is the absolute value of a firm's one-day earnings announcement return corresponding to quarter  $q$ ,  $RET_q$ .
- $SAMEDATE_q$  is the log of the number of firms in Compustat that have the same quarterly earnings announcement date as the firm.
- $SIZE_q$  is the firm's share price multiplied by total shares outstanding at the end of quarter  $q - 1$ .

**Table 1**  
*Descriptive Statistics and Correlations*

**Panel A: Descriptive Statistics**

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	Mean	Med	StdDev
<i>IAV</i>	0.064	0.058	0.036
<i>ExVOL</i>	0.149	0.231	0.420
<i>COMOVE</i>	-0.011	-0.009	0.011
<i>ANBETA</i>	0.113	0.069	1.446
<i>SAMEDATE</i>	5.283	5.455	0.745
<i> RET </i>	4.567	2.938	4.905
<i>SIZE</i>	7.583	7.439	1.480
<i>LBM</i>	0.328	0.305	0.184
<i>MKTSHR</i>	2.371	0.465	4.955
<i>HISTRET</i>	4.332	3.689	2.735
<i>DISP</i>	0.097	0.046	0.157
<i> FE </i>	0.002	0.001	0.004

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**Table 1 (continued)**  
*Descriptive Statistics and Correlations*

**Panel B: Pearson (Spearman) Correlations Above (Below) the Diagonal**

	<i>IAV</i>	<i>ExVOL</i>	<i>COMOVE</i>	<i>ANBETA</i>	<i>SAMEDATE</i>	<i> RET </i>	<i>SIZE</i>	<i>LBM</i>	<i>MKTSHR</i>	<i>HISTRET</i>	<i>DISP</i>	<i> FE </i>
<i>IAV</i>		-0.07	-0.18	0.01	0.10	0.17	-0.15	-0.05	-0.08	0.23	0.03	0.03
<i>ExVOL</i>	-0.06		0.34	-0.01	0.03	-0.26	0.28	0.08	0.14	-0.38	-0.03	-0.06
<i>COMOVE</i>	-0.18	0.39		-0.10	0.00	-0.28	0.19	0.04	0.11	-0.78	-0.01	-0.05
<i>ANBETA</i>	0.00	-0.01	-0.09		0.02	0.02	0.00	0.00	0.01	0.05	-0.01	-0.01
<i>SAMEDATE</i>	0.12	0.03	0.00	0.00		0.01	0.01	-0.01	-0.05	0.03	0.01	0.00
<i> RET </i>	0.16	-0.27	-0.29	0.02	0.00		-0.16	-0.08	-0.09	0.34	0.03	0.09
<i>SIZE</i>	-0.14	0.29	0.20	-0.01	0.01	-0.16		-0.24	0.40	-0.29	-0.22	-0.27
<i>LBM</i>	-0.06	0.12	0.08	0.00	-0.01	-0.10	-0.21		0.02	-0.07	0.26	0.28
<i>MKTSHR</i>	-0.14	0.24	0.18	0.00	-0.07	-0.16	0.59	0.11		-0.15	-0.04	-0.12
<i>HISTRET</i>	0.23	-0.44	-0.76	0.05	0.02	0.36	-0.34	-0.11	-0.33		0.07	0.13
<i>DISP</i>	0.03	0.01	0.00	0.00	0.02	0.01	-0.18	0.33	-0.05	0.06		0.48
<i> FE </i>	0.05	-0.06	-0.06	0.00	0.01	0.09	-0.24	0.24	-0.06	0.11	0.52	

Panel A provides descriptive statistics and Panel B provides Pearson and Spearman correlation coefficients. The sample consists of 45,181 firm-quarters from 1996 to 2007. See Appendix A for variable descriptions.

**Table 2**  
*Descriptive Statistics across Implied Announcement Volatility, IAV, Portfolios*

	<i>RET</i>	<i>SIZE</i>	<i>LBM</i>	<i>MKTSHR</i>	<i>HISTRET</i>	<i>DISP</i>	<i>FE</i>
1 (Low <i>IAV</i> )	3.853	7.631	0.344	2.462	3.742	0.106	0.227
2	3.649	7.804	0.333	2.732	3.600	0.085	0.172
3	3.760	7.872	0.322	2.866	3.666	0.079	0.157
4	3.967	7.763	0.324	2.917	3.808	0.083	0.163
5	4.083	7.783	0.318	2.798	3.874	0.088	0.170
6	4.313	7.648	0.320	2.615	4.096	0.086	0.172
7	4.518	7.546	0.321	2.248	4.312	0.092	0.186
8	4.795	7.422	0.320	2.190	4.616	0.096	0.194
9	5.375	7.239	0.325	1.859	4.911	0.101	0.214
10 (High <i>IAV</i> )	6.194	6.917	0.314	1.265	5.602	0.114	0.256
High – Low	2.341	-0.714	-0.031	-1.197	2.358	0.008	0.029
High – Low <i>p</i> -value	0.000	0.000	0.000	0.000	0.000	0.206	0.017

The table presents firm-specific descriptive statistics across deciles of option-implied announcement volatility, *IAV*. The sample consists of 45,181 firm-quarters from 1996 to 2007. See Appendix A for variable descriptions.

**Table 3***Implied Announcement Volatility and Realized Announcement Returns and Firm Characteristics*

$$X_q = \lambda_0 + \lambda_1 SIZE_q + \lambda_2 LBM_q + \lambda_3 MKTSHR_q + \lambda_4 HISTRET_q + \lambda_5 DISP_q + \lambda_6 |FE|_q + \varepsilon_q$$

<b>Panel A: Implied Announcement Volatility, <i>IAV</i>, as dependent variable</b>						
	Pred.	(1)	(2)	(3)	(4)	(5)
<i>Intercept</i>	+	7.948*** (54.97)	8.007*** (55.07)	6.158*** (42.41)	6.042*** (41.96)	5.977*** (41.55)
<i>SIZE</i>	-	-0.229*** (-12.63)	-0.173*** (-7.29)	-0.077*** (-3.26)	-0.073*** (-3.11)	-0.069*** (-2.93)
<i>LBM</i>	-	-0.112*** (-7.23)	-0.092*** (-6.47)	-0.041*** (-3.48)	-0.051*** (-4.23)	-0.053*** (-4.41)
<i>MKTSHR</i>	-		-0.089*** (-4.05)	-0.071*** (-3.66)	-0.071*** (-3.68)	-0.071*** (-3.70)
<i>HISTRET</i>	+			0.246*** (14.02)	0.246*** (13.88)	0.245*** (13.84)
<i>DISP</i>	+				0.032*** (3.04)	0.022** (2.07)
<i> FE </i>	+					0.024*** (2.81)
Adj R-Squared		0.034	0.037	0.067	0.068	0.068
<b>Panel B: Realized Absolute Announcement Return, <i> RET </i>, as dependent variable</b>						
	Pred.	(1)	(2)	(3)	(4)	(5)
<i>Intercept</i>	+	7.300*** (35.64)	7.368*** (34.99)	3.731*** (25.90)	3.688*** (25.06)	3.403*** (22.88)
<i>SIZE</i>	-	-0.364*** (-20.81)	-0.297*** (-11.04)	-0.109*** (-5.60)	-0.107*** (-5.54)	-0.088*** (-4.67)
<i>LBM</i>	-	-0.243*** (-12.50)	-0.220*** (-12.39)	-0.120*** (-10.24)	-0.124*** (-10.75)	-0.136*** (-11.86)
<i>MKTSHR</i>	-		-0.104*** (-3.68)	-0.068*** (-3.43)	-0.068*** (-3.43)	-0.069*** (-3.56)
<i>HISTRET</i>	+			0.484*** (25.88)	0.484*** (25.84)	0.480*** (25.51)
<i>DISP</i>	+				0.012 (0.96)	-0.028** (-2.21)
<i> FE </i>	+					0.102*** (9.04)
Adj R-Squared		0.054	0.056	0.120	0.120	0.122

Panel A (B) presents the regression summary statistics for regressions of implied announcement volatility, *IAV* (realized absolute return, *|RET|*) on firm characteristics. The sample consists of 45,181 firm-quarters from 1996 to 2007. *t*-statistics based on firm and quarter-clustered standard errors are shown in parentheses. See Appendix A for variable descriptions. \*\*\*, \*\*, and \* denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test.

**Table 4***Announcement Volatility Risk Premiums and Non-diversifiable Earnings Announcement Risk*

$$ExVOL_q = \alpha_0 + \alpha_1 COMOVE_q + \alpha_2 ANBETA_q + \alpha_3 SAMEDATE_q + \varepsilon_q$$

	Pred.	(1)	(2)	(3)	(4)
<i>Intercept</i>	?	0.149*** (15.14)	0.149*** (13.90)	0.149*** (13.87)	0.148*** (15.10)
<i>COMOVE</i>	+	0.135*** (22.17)			0.136*** (22.26)
<i>ANBETA</i>	+		-0.004 (-1.06)		0.007** (2.16)
<i>SAMEDATE</i>	+			0.019*** (3.53)	0.017*** (3.84)
Adj R-Squared		0.104	0.000	0.002	0.106

The table presents the regression summary statistics for regressions of volatility risk premiums, *ExVOL*, on measures of non-diversifiable risk. The sample consists of 45,181 firm-quarters from 1996 to 2007. *t*-statistics based on firm and quarter-clustered standard errors are shown in parentheses. See Appendix A for variable descriptions. \*\*\*, \*\*, and \* denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test.

**Table 5**  
*Announcement Volatility Risk Premiums by Expected Earnings Announcement Dates*

$$ExVOL_q = \alpha_0 + \alpha_1 COMOVE_q + \alpha_2 ANBETA_q + \alpha_3 SAMEDATE_q + \varepsilon_q$$

	All	Early Announcers	On-Time Announcers	Late Announcers
	(1)	(2)	(3)	(4)
<i>Intercept</i>	0.465*** (64.45)	0.479*** (55.45)	0.451*** (60.64)	0.486*** (49.78)
<i>COMOVE</i>	0.057*** (13.71)	0.048*** (9.14)	0.063*** (14.13)	0.054*** (9.15)
<i>ANBETA</i>	0.001* (1.84)	0.003** (2.50)	0.001* (1.88)	0.001 (1.18)
<i>SAMEDATE</i>	0.009** (2.42)	0.008 (1.64)	0.011*** (2.65)	0.008 (1.58)
Adj R-Squared	0.040	0.031	0.046	0.037
N	40,099	8,225	22,906	8,968

The table presents the regression summary statistics for regressions of volatility risk premiums, *ExVOL*, on measures of non-diversifiable risk. The sample consists of 45,181 firm-quarters from 1996 to 2007. Early, On-time, and Late denote whether the firm announced earnings before, within one day of, or after the expected earnings announcement date, estimated as in Cohen, Dey, Lys, and Sunder (2007). *t*-statistics based on firm and quarter-clustered standard errors are shown in parentheses. \*\*\*, \*\*, and \* denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test.



**Table 6**

*Announcement Volatility Risk Premiums and Non-Diversifiable Earnings Announcement Risk by Sample Partitions*

$$ExVOL_q = \alpha_0 + \alpha_1 COMOVE_q + \alpha_2 ANBETA_q + \alpha_3 SAMEDATE_q + \varepsilon_q$$

**Panel A: Sign of Earnings News**

	Good News (1)	Bad News (2)	<i>p</i> -value for Differences
<i>Intercept</i>	0.144*** (15.34)	0.162*** (12.96)	0.000
<i>COMOVE</i>	0.136*** (22.93)	0.137*** (15.04)	0.808
<i>ANBETA</i>	0.005 (1.58)	0.011*** (2.68)	0.061
<i>SAMEDATE</i>	0.015*** (3.27)	0.022*** (3.90)	0.106
Adj R-Squared	0.106	0.107	
N	33,580	11,601	

**Panel B: Management Earnings Guidance**

	Guidance (1)	No Guidance (2)	<i>p</i> -value for Differences
<i>Intercept</i>	0.138*** (15.37)	0.154*** (13.02)	0.000
<i>COMOVE</i>	0.140*** (15.67)	0.134*** (21.54)	0.134
<i>ANBETA</i>	0.010** (2.21)	0.005 (1.57)	0.079
<i>SAMEDATE</i>	0.022*** (3.99)	0.014*** (2.77)	0.043
Adj R-Squared	0.109	0.105	
N	15,082	30,099	

**Table 6 (continued)**

*Announcement Volatility Risk Premiums and Non-Diversifiable Earnings Announcement Risk by Sample Partitions*

$$ExVOL_q = \alpha_0 + \alpha_1 COMOVE_q + \alpha_2 ANBETA_q + \alpha_3 SAMEDATE_q + \varepsilon_q$$

**Panel C: Larger and Smaller Firms**

	Larger Firms (1)	Smaller Firms (2)	<i>p</i> -value for Differences
<i>Intercept</i>	0.228*** (24.66)	0.055*** (4.19)	0.000
<i>COMOVE</i>	0.162*** (18.36)	0.097*** (13.85)	0.000
<i>ANBETA</i>	0.009* (1.91)	0.005 (1.31)	0.120
<i>SAMEDATE</i>	0.030*** (5.52)	0.002 (0.37)	0.000
Adj R-Squared	0.126	0.062	
N	22,601	22,580	

The table presents the regression summary statistics for regressions of volatility risk premiums, *ExVOL*, on measures of non-diversifiable risk. The sample consists of 45,181 firm-quarters from 1996 to 2007. Good News and Bad News in Panel A denote whether the quarterly earnings forecast error,  $FE_q$ , is positive or negative. No Guidance and Guidance in Panel B denote whether the firm provided management guidance within the three-day earnings announcement window, i.e., between days  $t - 1$  and  $t + 1$  relative to the announcement date. Larger Firms and Smaller Firms in Panel C denote whether the firm's market capitalization is above (below) the annual median. *t*-statistics based on firm and quarter-clustered standard errors are shown in parentheses. See Appendix A for variable descriptions. \*\*\*, \*\*, and \* denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test.

**Table 7**

*Announcement Volatility Risk Premiums and Non-Diversifiable Earnings Announcement Risk, Including Controls for Other Sources of Non-Diversifiable Risk*

$$ExVOL_q = \alpha_0 + \alpha_1 SIZE_q + \alpha_2 BellWether_q + \alpha_3 EFAC_q + \alpha_4 HISTRET_q + \alpha_5 EFAC_q * HISTRET_q + \alpha_6 COMOVE_q + \alpha_7 ANBETA_q + \alpha_8 SAMEDATE_q + \varepsilon_q$$

	Pred.	(1)	(2)	(3)	(4)	(5)
<i>Intercept</i>	?	-0.001 (-0.09)	-0.004 (-0.30)	0.017 (1.30)	0.013 (0.98)	0.009 (0.68)
<i>SIZE</i>	+	0.236*** (14.19)			0.186*** (10.37)	0.181*** (10.02)
<i>BellWether</i>	+		0.750*** (8.98)		0.251*** (2.82)	0.301*** (3.20)
<i>EFAC</i>	?			-0.048*** (-3.96)	-0.036*** (-3.10)	-0.033*** (-2.81)
<i>HISTRET</i>	?			-0.302*** (-13.46)	-0.220*** (-9.90)	-0.329*** (-19.96)
<i>EFAC*HISTRET</i>	+			0.025** (2.24)	0.022** (2.01)	0.021** (1.97)
<i>COMOVE</i>	+	0.274*** (19.07)	0.327*** (23.00)	0.117*** (5.07)	0.133*** (5.90)	
<i>ANBETA</i>	+	0.011 (1.51)	0.015** (1.98)	0.010 (1.16)	0.007 (0.81)	
<i>SAMEDATE</i>	+	0.043*** (4.13)	0.041*** (3.98)	0.056*** (5.45)	0.055*** (5.26)	
Adj R-Squared		0.162	0.111	0.158	0.191	0.182

The table presents the regression summary statistics for regressions of volatility risk premiums, *ExVOL*, on measures of non-diversifiable risk. The sample consists of 2,576 firms with at least ten quarterly earnings announcements from 1996 to 2007. Firm-specific control variables are averaged across all quarters in the sample. *t*-statistics based on firm and quarter-clustered standard errors are shown in parentheses. See Appendix A for variable descriptions. \*\*\*, \*\*, and \* denote significance at the 0.01, 0.05, and 0.10 levels, based on a two-sided test.

**Table 8**  
*Implied expected correlations between S&P500 returns and Non-Diversifiable Earnings  
Announcement Risk as reflected in Comovement of Returns, COMOVE*

**Panel A: Mean Statistics by Quintile of COMOVE**

	OBS	<i>IMPCORR</i>
1 (Low <i>COMOVE</i> )	27	0.314
2	28	0.320
3	28	0.334
4	28	0.390
5 (High <i>COMOVE</i> )	28	0.463
High – Low		0.149
High – Low <i>p</i> -value		0.000

**Panel B:  $IMPCORR_m = \alpha_0 + \alpha_1 \overline{COMOVE}_m + \alpha_2 IMPCORR_{m-1} + \varepsilon_m$**

	(1)	(2)
<i>Intercept</i>	0.584*** (10.95)	0.645*** (8.30)
<i>COMOVE</i>	20.064*** (4.41)	22.298*** (4.88)
Adj R-Squared	0.150	0.222
Month Fixed Effects	No	Yes

The table presents statistics for the monthly implied expected correlations between the returns for the S&P500 firms, *IMPCORR*, and non-diversifiable earnings announcement news,  $\overline{COMOVE}_m$ . The sample consists of 137 months from 1996 to 2007. *t*-statistics based on two-way cluster robust standard errors are shown in parentheses. See Appendix A for variable descriptions. \*\*\* and \*\* denote significance at the 0.01 and 0.05 levels, based on a two-sided test.