The Information Content of Implied Skewness and Kurtosis Changes Prior to Earnings Announcements for Stock and Option Returns

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Abstract

We explore whether changes in stock return skewness and kurtosis, as implied in option prices preceding earnings announcements, provide information about subsequent stock and option returns through the announcement. We demonstrate that the change in skewness and kurtosis can be related to changing jump risk premiums, where jump risk can be associated with the uncertainty around the direction and size of the stock price response to the earnings announcement. As such, implied skewness (kurtosis) should capture the direction (magnitude) of a stock jump if option prices change as a result of changing jump risk size and intensity. Examining changes in implied skewness and kurtosis preceding over 74,000 earnings announcements for over 4700 firms, we find that both moments have strong predictive power for future stock returns, even after controlling for implied volatility. Additionally, changes in both moments predict call returns, while put return predictability is primarily linked to skewness. Thus, prior to earnings announcements, option prices contain information about future security returns.

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I. Introduction

Understanding how information flows between different markets, such as the option and stock markets, is an important finance topic. As stated by Black (1975), "An investor who wants the action on a stock has two ways of getting it. He can deal directly in the stock, or he can deal in the option." Black (1975) also suggests that traders with private information prefer to exploit that information by trading in the options market. He argues that option markets provide lower short selling costs and higher leverage, and that many potential information traders will trade in the options market when they may not trade at all in the absence of option markets. The likely result is that information is reflected in option prices before it is reflected in stock prices.[1] Evidence in Bali and Hovramathin (2008), Cremers and Weinbaum(2008), Diavatopoulos, Doran and Peterson (2008), and Zhang, Zhao, and Xing (2008) is consistent with Black's conclusion.

We add to the literature by focusing on a period of time immediately preceding earnings announcement dates and examining if option prices provide information about future stock and option returns. Earnings announcements are often rich in information content. Most of the analysis of the earnings announcements centers on stock returns on the event day(s) or the subsequent period. Abnormal returns following the event day(s) are typically referred to as the post earnings announcement drift.[2] We specifically analyze whether changes in stock return skewness and kurtosis, as implied in option prices before the earnings announcement, are related to future stock and option returns. We argue that implied skewness and kurtosis are likely to be at least as valuable in providing information about future earnings as the implied variance, and link these

[1] Many studies address the general lead-lag relation between option and stock prices. For example, Manaster and Rendelman (1982) posit that option markets may provide a preferred outlet for informed investors. They find that the closing prices of call options contain information about equilibrium stock prices that is not contained in the closing prices of the underlying stocks. Sheikh and Ronn (1994) find that option returns contain systematic patterns even after adjusting for patterns in the means and variances of the underlying assets. This is consistent with the hypothesis that informed trading in options can make the options market informative about the value of the underlying asset.

[2] For example, Beaver (1968), Ball and Brown (1968), Landsman and Maydew (2002), and Battalio and Mendenhall (2005) are just a few of the numerous studies that examine announcement day effects and post earnings announcement drift.

changes in the third and fourth moments to changes in jump risk premiums in the underlying data generating process. This provides a theoretical foundation that prior studies ignore.

With respect to the presence of options, most literature on stock returns and earnings announcements addresses differences in stock returns between option and non-option firms. In particular, Jennings and Starks (1986), Skinner (1990), Ho (1993), and Mendenhall and Fehrs (1999) find that firms with traded options tend to have quicker price responses and smaller surprises than those that do not. This suggests that option listing improves the informational efficiency of the market for the underlying stock. Amin and Lee (1997) find that trading volume in options increases by more than 10% in the four days before quarterly earnings announcements while trading volume in stocks increases by less than 5%, providing further support for increased efficiency for stocks with listed options. They also find that option traders initiate a greater proportion of long (short) positions immediately before good (bad) earnings news. This suggests that informed traders may prefer to deal in options when they have an important piece of information, consistent with Black's (1975) hypothesis.

Other studies investigate the role of stock return volatility implied in option prices and the relation with future stock returns. Patell and Wolfson (1979, 1981) find that implied volatility, as calculated from the Black and Scholes (1973) pricing model, increases before earnings announcements and decreases following them. Zhang, Zhao, and Xing (2008) use implied stock return volatilities from options to focus on the general predictability and information content of volatility skews for future equity returns. As an aside, they present evidence that the shape of the volatility skew is related to the surprise in earnings announcements, with firms with the steepest volatility smirks experiencing the worst earnings surprise in subsequent months.

The findings in Patell and Wolfson (1979, 1981) and Zhang, Zhao, and Xing (2008) imply two specific relations between the option and stock markets; first, option traders increase the price and volatility of an option prior to an earnings announcement and, second, the shape of the volatility skew may imply the direction of the announcement. We extend the finding in these prior works in four important ways. First, we focus on changes versus levels of implied moments because implied parameters should change as the options market anticipates the size and direction of the approaching announcement. Second, we separate the volatility skew change into the 2^{nd}, 3^{rd}, and 4^{th} moments of the implied distribution to relate the given moment to the direction and magnitude of the anticipated stock price response. Third, we focus on stock and option returns prior to and at earnings announcements, versus earnings surprises, which may reveal a potential trading strategy. Fourth, we provide simulation evidence linking implied moment changes to underlying risk premiums, demonstrating how options markets and earnings announcements are related.

We expect that the price response of a stock to good or bad news on the day of an earnings announcement poses significant risk to the short options trader, especially if the option is close to expiration. This risk is a function of not only the direction of the news and the resulting stock price response, but also the magnitude of the information and related stock jump. The trader can adjust to these risks by increasing the price of all options via increasing the volatility used to price the options, or altering the volatility of those that are most at risk, i.e. out-of-the-money options. We relate these risks, what can be thought of as the jump size and intensity risks, to the moments implied in the risk-neutral distribution. In other words, do option prices embed accurate expectations about the direction and magnitude of future stock price movement associated with earnings announcements? The former may be measured by the expected stock return skewness that is implied in option prices and the latter by the implied kurtosis. The purpose of this study is to determine if implied skewness and kurtosis are useful for predicting future stock and option returns preceding and at earnings announcements.

Specifically, beginning 30 trading days prior to an earnings announcement, we calculate changes in implied skewness and kurtosis over various periods and examine subsequent stock and option returns. In so doing we provide direct evidence on whether important information at earnings announcements is incorporated in option prices before the announcement and the value of that information for earning future returns.

We sort securities based on their two-day buy-and-hold returns (BHRs) over the earnings announcement date (day 0) and the following trading day (day 1). We find a direct relation between these BHRs and changes in implied skewness and kurtosis measured from days -30 through -5. We then sort securities into five groups based on skewness changes over three different intervals preceding earnings announcements and separately sort on kurtosis changes. In both cases the future BHRs beginning the day after the change through day 1 are significantly greater for the high change quintile than the low change quintile. Thus, skewness and kurtosis changes predict future returns. These predictive abilities hold even after we control for implied volatility.

We perform five-by-five double sorts on changes in implied skewness and kurtosis and find that the BHRs of the high skewness change group outperform those of the low skewness change group across kurtosis change quintiles, but the significant return differences are more concentrated in the higher kurtosis change quintiles. The BHRs of the high kurtosis change group significantly outperform those of the low kurtosis change group only for the two highest skewness change groups. These results indicate that changes in both implied skewness and kurtosis contribute to return predictability, but the relations tend to be strongest for high skewness and kurtosis change stocks.

We next examine call and put BHRs following changes in implied skewness and kurtosis. As with stock, we find strong evidence that these changes can predict option returns. Finally, we estimate firm-level regressions with stock, call, and put BHRs as dependent variables. Independent variables include skewness and kurtosis changes, an interaction term between these two variables, and a set of control variables. We find that stock and call returns, beginning after skewness and kurtosis changes and continuing through day 1, are significantly related to the changes. Put returns are related to prior skewness changes, but only very weakly related to kurtosis changes. Overall, information about future earnings announcements, embedded in implied skewness and kurtosis, is related to future stock and option returns.

This study is developed in the following sections. Section II presents our methodology and motivation, including the methods of estimating implied skewness and kurtosis changes, a link between risk premiums and implied moments, a simulation analysis examining this link, and a discussion of our data. Empirical results are provided in Section III and Section IV concludes.

II. Methodology and Motivation

A. Measures of Implied Skewness and Kurtosis

Our hypothesis is that information about earnings announcements is embedded in option prices prior to the announcement and that this information is useful for predicting stock returns.[3] A typical approach in earnings announcement studies is to focus on abnormal stock returns. If option prices predict stock returns, however, the price of an option will reflect the anticipated changes in the stock price, which may be related to the jump premium. The stock price change is comprised of abnormal and normal returns. Thus, we examine total stock returns at and preceding the earnings announcement.[4]

If information about earnings announcements is present in option prices prior to the announcement then, compared to a base period, we expect two effects to occur that can affect option prices. First, if the direction of the price response to an earnings announcement is anticipated, then we expect implied skewness to change. If a positive (negative) jump occurs, then the implied skewness should become more positive (negative). In other words, out-of-the-money (OTM) calls (puts) will increase relative to at-the-money (ATM) options if a positive (negative) jump is expected. To capture the information in implied skewness, we employ the non-parametric measure of Bakshi, Kapadia, and Madan (2003). Implied skewness is defined as:

$$SKEW_t = \frac{e^{r\tau}W(t,\tau) - 3e^{r\tau}\mu(t,\tau)v(t,\tau) + 2\mu(t,\tau)^2}{(e^{r\tau}v(t,\tau) - \mu(t,\tau)^2)^{\frac{3}{2}}} \qquad (1)$$

where r is the risk free rate, t is the time today, τ is the time at expiration, and $W(t,\tau), \mu(t,\tau),$ and $v(t,\tau)$ are defined in Appendix A. This measure expresses implied skewness as a single value by using information in both OTM calls and puts, providing a

[3] Under this hypothesis, two types of stock price adjustment processes may not be fully functioning. First, if the stock market anticipates earnings information the way the options market does, then stock prices should also adjust. Therefore, the stock market is responding to information about earnings less efficiently than the options market. Second, even if stockholders know nothing about earnings, option prices are adjusting. Therefore, investors could initiate trades using the put-call parity relation between stocks and options to bring stock prices into line. However, the put-call parity adjustment may not be fully working. One reason may be that strict put-call parity holds only for European options and we are using American options for which a put-call parity inequality holds. This allows a looser relation between prices of stocks and options. Also, investors who try to exploit the relation between stock and option prices, as indicated by put-call parity, might be faced with large transaction costs and bid-ask spreads. These impediments could cause the stock price adjustment process to lag behind the option price adjustment process.

[4] Benchmark returns are likely small over a two-day announcement window. Thus, the total stock return at the announcement is likely very close to, and highly correlated with, the two-day abnormal return.

simple alternative to dividing the skew into parts. Studies such as Doran, Peterson, and Tarrant (2007), Dittmar, Conrad, and Ghysels (2008), and Agarwal, Bakshi, and Huij (2008) demonstrate that this measure is informative for identifying potential market crashes, capturing assets bubbles, and explaining hedge fund returns, respectively.

The second effect that changes option prices may be a result of the uncertainty of the stock price response. This occurs if option traders are worried about a large stock price response, but are unsure of the direction. Here, we expect that *both* OTM calls and puts will increase relative to ATM options, or there will be an increase in density in the tails of the implied distribution. To capture implied kurtosis we use the measure calculated in Bakshi, Kapadia, and Madan (2003), given as,

$$KURT_t = \frac{e^{r\tau}X(t,\tau) - 4e^{r\tau}\mu(t,\tau)W(t,\tau) + 6e^{r\tau}\mu(t,\tau)v(t,\tau) - 3\mu(t,\tau)^4}{(e^{r\tau}v(t,\tau) - \mu(t,\tau)^2)^2} \tag{2}$$

where $X(t,\tau)$ is defined in Appendix A. Unlike prior studies which focus primarily on the second and, in more limited fashion, the third moment, we feel there is significant information in the fourth moment. Pan (2002) and Bakshi and Cao (2008) show that incorporating jumps in the underlying data generating process is critical for fitting the return distribution of both stock and option prices. Even more critical is the notion of a jump risk premium, capturing the difference between the implied and risk neutral distributions, or the difference between option and stock prices. This jump premium cannot be fully captured by implied skewness, since skewness implies a direction. The jump premium may be related to the intensity of a jump, which is captured by kurtosis.[5]

Since our analysis is concerned with how information is incorporated in implied skewness and kurtosis, we focus on the change in both these measures. Using an initial point in time, ω, and a subsequent point in time, Ω, we calculate the level of implied skewness and kurtosis from equations (1) and (2) for both periods. The change over the period is given as,

[5] Several studies, including Patell and Wolfson (1979, 1981) and Zhang, Zhao, and Xing (2008), focus on implied variances. An implied variance may not be the best measure of the value of information, however, because it will naturally increase as the earnings announcement date approaches due to the imminent uncertainty. Much of our analysis controls for implied variances and this allows us to focus on the anticipated direction (skewness) and magnitude (kurtosis) of future stock returns.

$$\Delta SKEW_{\omega,\Omega} = SKEW_{\Omega} - SKEW_{\omega} \quad (3)$$

$$\Delta KURT_{\omega,\Omega} = KURT_{\Omega} - KURT_{\omega} \quad (4)$$

As a control, we also calculate the change in implied volatility over the same periods since we want to distinguish between the information content of each moment. The initial point (ω) of the moment change measures is 30 trading-days prior to the earnings announcement date (day 0). Thirty trading-days prior to the earnings announcement represents our base period where we hypothesize there is little, if any, information about the future earnings announcement embedded in stock or option prices. There are three different ending points (Ω) of the moment change measures. These are 20, 10, and 5 trading-days prior to the earnings announcement date. We examine these multiple time horizons to determine not only if information is captured in the implied moments, but how that information evolves over time.

If directional information is contained in these implied moments, then we expect higher positive (negative) implied skewness changes for firms with the highest (lowest) returns on the earnings announcement date and the following trading day (days 0 and 1). If there is increased jump uncertainty, we expect higher kurtosis changes for firms with *both* the lowest and highest returns over these periods. Following the skewness and kurtosis changes over the windows identified above, we examine subsequent stock and option BHRs through day 1. We examine whether there is a relation between the skewness and kurtosis changes and subsequent returns.

B. The Link of Jump Size and Intensity Risk to Implied Skewness and Kurtosis

Prior to estimating the relation between the implied moments and announcement day returns, it is necessary to establish why these implied moments change and how option prices capture information that stock prices do not. Implied skewness and kurtosis are a function of a risk-neutral data generating process, one that specifically incorporates jumps. As Pan (2002) shows, it is necessary to incorporate jumps and jump premiums to capture the negatively skewed distribution of S&P 500 option prices. Consequently, we link the size and intensity of the jumps to the shape of the risk neutral distribution.

To capture the relation of jump risk premiums with implied skewness and kurtosis, quasi-Monte Carlo simulations are performed. The stock process follows the

Bates (1996) stochastic volatility model with jumps (SVJ). As in Heston (1993), the price and volatility processes follow geometric Brownian motion and the square-root process, respectively. Price jumps are captured by the Poisson distributed jump-process Π, which is conditional on volatility. The risk-neutral SVJ process is given in equations (5) and (6).

$$\frac{dS_t}{S_t} = rdt + \sigma_t dz_S^* - \mu_\pi^* \sigma_t \lambda dt + d\Pi_t^* \tag{5}$$

$$d\sigma_t^2 = \left(\kappa(\theta - \sigma_t^2)\right)dt + \xi\sigma_t(\rho dz_S^* - \sqrt{1-\rho^2}dz_\sigma^*) \tag{6}$$

Option prices are determined under a risk-neutral measure where the premiums for price, volatility and jump risk are equal to zero. The stock price process requires transforming the risk-neutral measure to the real-world, or realized measure which incorporates risk premiums for these three sources of risk. The transformed real-world process is given in equations (7) and (8),

$$\frac{dS_t}{S_t} = (r + \lambda_s \sigma_t)dt + \sigma_t dz_S - \mu_\pi \sigma_t \lambda(1-\lambda_\pi)dt + d\Pi_t \tag{7}$$

$$d\sigma_t^2 = (\kappa(\theta - \sigma_t^2) + \lambda_\sigma \xi \sigma_t)dt + \xi\sigma_t(\rho dz_S - \sqrt{1-\rho^2}dz_\sigma) \tag{8}$$

where $\lambda_s, \lambda_\sigma, \lambda_\pi,$ are measures of price, volatility, and jump intensity risks, respectively, μ_π and μ_π^* are the real-world and risk-neutral mean jump sizes, respectively, ξ is the volatility of the variance, κ is the speed of mean-reversion of the variance, θ is the long-run variance mean, ρ is the correlation between the price and variance processes, λ is the jump intensity or arrival rate, dz_S and dz_σ are real-world geometric Brownian motions, and dz_S^* and dz_σ^* are transformed risk-neutral geometric Brownian motions. $\mu_\pi^* \sigma_t \lambda dt$ is the compensation for instantaneous changes in returns resulting from the jump-process Π. Market prices of risk are introduced in the transformation from risk-neutral to the real-world densities via the Girsanov Theorem. For the risk-neutral and real-world processes, jumps are drawn from a $N \sim (\mu_\pi^*, \sigma_\pi^2)$ and $N \sim (\mu_\pi, \sigma_\pi^2)$ respectively, where σ_π^2 is the variance of jump sizes. State-dependent arrival rates are given by $\sigma_t \lambda$ and $\sigma_t \lambda(1-\lambda_\pi)$. This specification allows us to test two elements of jump uncertainty, the jump size risk $(\mu_\pi^* - \mu_\pi)$ and the jump arrival risk, $\sigma_t \lambda(\lambda_\pi)$, where λ_π can be thought of as a premium for the uncertainty in the jump arrival.

Two variance control techniques are implemented to reduce option value standard errors and improve the efficiency of the results. For each sample path, random shocks are drawn from $N{\sim}(0, \sqrt{\Delta t})$ at Δt intervals over the life of options. Initially, for an option with 30-days until expiration, 30 random shocks, one per day, are drawn for the price process for 30 trading days. For an option with 10-days to expiration, 10 random shocks are drawn. This procedure is repeated for the volatility process governed by the correlated Brownian motions. To generate both risk-neutral and real-world paths, four random draws are performed for each daily evolution. Call and put option values are calculated as the average value across all n paths. Under the risk-neutral measure,

$$C_{n,t} = e^{-r(T-t)} \max(S_{n,t} - K, 0) \tag{9}$$

$$P_{n,t} = e^{-r(T-t)} \max(-S_{n,t} + K, 0) \tag{10}$$

where $S_{n,t}$ is the stock price at time T (option expiration) for path n and K is the strike price. 40,000 price paths are estimated to improve the efficiency of the simulated option values. This is important when estimating implied volatilities, since incorrect option prices can lead to large errors. Final call and put values are given as,

$$\overline{C_t} = \frac{1}{n}\sum_{i=1}^{n} C_{i,t} \tag{11}$$

$$\overline{P_t} = \frac{1}{n}\sum_{i=1}^{n} P_{i,t} \tag{12}$$

Implied volatility, σ_{IV}, is determined using the closed form Black-Scholes formula, given starting values for the stock price, risk-free rate, time to expiration and strike price. Applying this formula in the presence of jumps and stochastic volatility may appear contradictory, but is consistent with determining the effects of various risk premiums. To eliminate potential price impacts and focus only on jump risk, early exercise is not incorporated in simulations.[6]

[6] In empirical estimation, early exercise premiums are minimal given the short time to expiration.

C. Simulation Results

To estimate the effect of changing risk premiums through time, we estimate option prices and volatility with 30-days until expiration using a starting stock price of \$100, a risk-free rate of 3%, an underlying volatility of 50%, and strike prices ranging from \$80 to \$120 in \$1 increments. The stochastic volatility parameters, κ,θ, ξ, and ρ, are set equal to 2, .25, .3 and -.5, respectively, and never change. A negative ρ results in a negative implied volatility skew. The jump parameters λ, λ_Π, μ_Π^*, μ_Π, and σ_Π^2, are initially set equal to 1, 0, 0, 0, and .15, respectively. The risk premiums are all set equal to zero.[7] After estimating option prices and volatility with 30 days until expiration, four cases are estimated with 10-days to expiration but with the same range for strike prices. The four cases are:

I. All parameters remain the same
II. The jump size risk premium increases to 10% ($\mu_\Pi^* - \mu_\Pi = 10\%$)
III. The jump size risk premium decreases to -10% ($\mu_\Pi^* - \mu_\Pi = -10\%$)
IV. The jump intensity increases to 2 ($(1 - \lambda_\Pi) = 2$)

After each simulation, $\Delta SKEW_{\omega,\Omega,i}$ and $\Delta KURT_{\omega,\Omega,i}$ are calculated, where ω is equal to 30, Ω is equal to 10, and *i* is one of the four cases. It is necessary to calculate the change in case (I) to determine the effect of time on $\Delta SKEW_{\omega,\Omega}$ and $\Delta KURT_{\omega,\Omega}$. If the mean jump size risk premium increases (decreases), then the price of OTM calls relative to OTM puts will increase (decrease) because of a higher probability of finishing in the money. As a result, the implied skewness will be more positive (negative) for case II (III) than the implied skewness in case I where the mean jump size is equal to zero.

When the arrival rate increases, then both the OTM put and call prices will increase because of an increased likelihood of finishing in the money, irrespective of the jump size. The effect on the price increase for the OTM options is also greater than the

[7] Multiple simulations were conducted over a different range of parameters, including positive correlation, ρ, lower underlying volatility, a faster mean reversion, κ. While the volatility skew shape changes as a function of these parameters, the effect of changing risk premiums remains the same.

price increase for ATM options. As such, implied kurtosis should be higher for case IV than case I. Thus, our expectation is that,

$$\Delta SKEW_{\omega,\Omega,II} > \Delta SKEW_{\omega,\Omega,I}$$

$$\Delta SKEW_{\omega,\Omega,III} < \Delta SKEW_{\omega,\Omega,I}$$

$$\Delta KURT_{\omega,\Omega,IV} > \Delta KURT_{\omega,\Omega,I} .$$

For case I, moving from a 30-day to 10-day option expiration results in $\Delta SKEW_{\omega,\Omega,I}$=.073 and $\Delta KURT_{\omega,\Omega,I}$=.934. For case (II) and (III), $\Delta SKEW_{\omega,\Omega,II}$=.246 and $\Delta SKEW_{\omega,\Omega,III}$=-.187, respectively, and for case (IV) $\Delta KURT_{\omega,\Omega,IV}$=1.139. For cases II, III, and IV, the new level is significantly different than case I, and in the expected direction. These differences in skewness and kurtosis should be reflected in higher option prices and higher implied volatility. For example, with case II the more positive implied skewness should be reflected empirically as a more positive volatility skew relative to the volatility skew for case I.

Figure 1 highlights the effect of these changing risk premiums by graphing the percentage difference and level difference in the option price and implied volatility for cases II, III, and IV, relative to case I. Each of the lines represents a fitted value of the individual data points. The fitted line for K/S less than 1 captures option price and implied volatility changes for OTM puts, for K/S greater than 1 the line captures the changes in OTM calls, and for K/S equal to 1 the line captures the average change in ATM calls and puts.

For case II, the percentage change in the option price and level change in the option volatility is greater for the OTM calls than the OTM puts. When the prices and implied volatilities of OTM calls increase relative to OTM puts, the SKEW, as calculated in equation (1), becomes more positive. The reverse is true for case III, where the prices and implied volatilities of OTM puts increase relative to OTM calls, and SKEW becomes more negative. For case IV, there is almost a symmetric increase in the OTM calls and puts relative to the ATM options, which results in a higher KURT. The two tails of the distribution do not increase equally because of the negative correlation between price and volatility innovations.

The simulation results reveal that if option traders are anticipating jump events, then the changes in implied skewness and kurtosis will reflect the direction and the uncertainty of the anticipated event. Additionally, the change in the implied moments, as a result of changing risk premiums, will be reflected in the options market prior to the stock market. As such, the empirical evidence should reveal that if option traders are informed, information should first appear in the options market and, potentially, allow for a trading strategy around earnings announcements.

D. Data

To test for whether skewness and kurtosis changes are related to the stock price response prior to and through the earnings announcement, daily stock return, share price and shares outstanding data are collected from CRSP for the period January 1996 through April 2007.[8] Earnings announcement dates (day 0) are obtained from Compustat, as well as the book value of equity. The sample is restricted to firms with traded options at least 30 trading days prior to an earnings announcement date. There are 4,746 firms and 74,027 announcement dates in the sample. Daily implied volatility and option price data are collected from OptionMetrics.[9] A standardized implied volatility is calculated as the moneyness weighted implied volatility where ATM options are given the most weight.

III. Empirical Results

A. Analysis Based on Single Sorts

In the first part of our analysis, we divide the sample into deciles based on stock BHRs over days 0 and 1. For each earnings announcement we calculate values of SKEW and KURT at trading-days -5, -10, -20, and -30, and then the respective changes from -30 to -20,-10, and -5. We expect greater positive (negative) skewness changes for firms in the higher (lower) BHR deciles if investors in the options market correctly anticipate the direction of earnings announcements. We expect greater positive kurtosis changes in both the higher and lower BHR deciles if investors in the options market anticipate a

[8] ETFs, foreign and financial firms, utilities, and securities with share codes other than 10 or 11 are excluded.

[9] We consider all firms with any traded option. Additionally we examine a smaller sub-sample of firms that have non-zero option volume and find similar results.

jump, but are unsure of the direction. When calculating SKEW and KURT for each company, we use the options with expirations having as short a maturity as possible subject to following day 1. These near-term options should best reflect the information content of earnings announcements.

Mean values for BHRs over days 0 and 1 and implied skewness, kurtosis, and volatility levels at days -5, -10, -20, and -30 are reported in Table 1, Panel A. The high minus low column in Panel A shows that for days -5, -10, and -20 implied skewness significantly increases from low to high earnings announcement BHRs; the relation is significant at the 1% level for days -5 and -10 and at the 5% level for day -20. The relation is insignificant for day -30. This shows the options market begins to anticipate information in earnings announcements at least 20 trading-days beforehand. All four implied kurtosis measures tend to peak for the middle BHR deciles. Nevertheless, for days -5 and -10 there are significant increases in implied kurtosis from the low to the high BHR category. This is somewhat surprising, since our expectation is that kurtosis should increase for a potential jump irrespective of direction. The difference between the high and low BHR deciles for days -5 and -10 suggests that kurtosis may be important for call options, but not put options. Implied volatility shows negligible change from low to high BHR deciles, with slightly lower levels for middle BHR deciles. This volatility pattern explains some of the kurtosis pattern. Since kurtosis is calculated as the fourth moment divided by the second moment squared, low levels of volatility for middle BHR deciles can be linked to high levels of kurtosis for the same deciles. For extreme BHR deciles volatility is relatively unchanged. Thus, changes in kurtosis from the low to the high decile are due to fourth moment changes, not second moment changes.

Changes in implied skewness, kurtosis, and volatility from day -30 to days -20, -10, and -5 are reported in Panel B. The results are consistent with those in Panel A. Changes in implied skewness and kurtosis are significantly greater, at the 5% level or better, for the high BHR decile than for the low BHR decile in all categories; in particular the high-low differences for all skewness and kurtosis changes are positive and statistically significant. The differences are numerically larger for greater lengths of time. Thus, option prices begin to reflect the information content of earnings announcements as the announcement date approaches. These results are important because they suggest that option traders treat anticipated positive and negative jumps differently.[10] Since the kurtosis changes are greatest in the high BHR deciles, this further suggests different information for calls and puts. Differences in volatility changes across BHR deciles are very small.

For all future analyses we group earnings announcements by the month in which they are made. We form averages of characteristics about these announcements by this monthly system and then form grand averages over our full sample period. This procedure minimizes effects of good or bad news clustering in time over the full period.

If option prices reflect earnings information prior to the announcement, implied skewness and kurtosis changes should be stronger for closer maturity options provided all expirations follow the announcement. This is because jump risk is highest for options closest to expiration. In Table 2, skewness and kurtosis changes are presented by option expiration. This table compares current options with the first expirations following the announcement (month *t* options) to those that have the next expiration (month *t+1* options).[11] Each month firms with an earnings announcement are divided into quintiles according to BHRs. In Panels A and B firms are divided according to BHRs over the period (-4,1) and skewness and kurtosis changes are reported over days (-30,-5). Differences in skewness and kurtosis between the two option expirations are expressed as the absolute value of the month t options minus the absolute value of the month t+1 options. Thus, a positive difference indicates a greater response for the month t options.[12] Skewness change differences should be largest in low (bad news) and high (good news) quintiles. Negative skewness changes should be seen in the low deciles with positive changes in the high deciles. Kurtosis changes should be positive across all quintiles and differences between expirations should also be positive.

Results in Panel A show that all of the skewness changes have the expected signs. The differences in absolute values between the two expirations are largest for quintiles 1 and 5, also as expected. However, none of the differences are statistically significant.

[10] If investors tend to buy more calls than puts, then option traders are faced with higher jump risk for positive information events.

[11] Most, but not all, of these subsequent expiration dates are one month beyond the closer expiration dates.

[12] The direction of the response in a given comparison is always the same for the two expirations.

All kurtosis changes are positive and the differences between expirations are all positive and significant at the 1% level; all kurtosis results are as expected.

We then repeat the analysis with returns over the period (-9,1), and skewness and kurtosis changes over the period (-30,-10). Results are presented in Panels C and D, and are virtually identical to those in Panels A and B. Finally, we analyze returns over the period (-19,1), and skewness and kurtosis changes over the period (-30,-20). Results are in Panels E and F and, again, are virtually identical to findings in Panels A and B. As a whole, results in Table 2 are consistent with the hypothesis that information about earnings is reflected in option prices prior to the earnings announcement. Patterns of implied kurtosis are strongly supportive of this conclusion while patterns of implied skewness offer much weaker support.

We now focus on near-term options and stock BHRs following implied skewness and kurtosis changes, through day 1.[13] Skewness and kurtosis changes are measured over the time periods (-30,-5), (-30,-10), and (-30,-20). Each month announcing firms are ranked by skewness and kurtosis changes over each of these three intervals and placed into equal-weighted portfolio quintiles and subsequent BHRs are calculated. Mean daily values over the sample period of BHRs for each quintile and high minus low quintiles are provided, along with the average skewness and kurtosis changes. Skewness results are presented in Table 3, Panel A, and Kurtosis results are in Table 3, Panel B.

The difference in BHRs between high and low quintiles is positive and statistically significant across all skewness and kurtosis change time horizons and subsequent return periods. For example, with skewness changes over days (-30,-5), an investor long stocks in the high skewness change quintile would realize an average daily 20.3 basis point return gain over an investor long stocks in the low skewness change quintile. Since a large positive kurtosis change can occur for either positive or negative anticipated stock price jumps, a kurtosis change alone cannot explain the positive BHR differences across high and low kurtosis change quintiles. Nevertheless, our kurtosis change results in Table 1, Panel B, show that the kurtosis change for negative jumps (low BHR deciles) and no jumps (middle BHR deciles) are very similar. Therefore, the large

[13] All options expire after the earnings announcement. Controlling for when the option expires after the announcements does not change the results.

positive kurtosis changes observed in Table 3, Panel B, are likely due to anticipated positive jump announcements. The results in Table 3 support our hypothesis that option prices reflect earnings information prior to the announcement. Following option price changes, stock prices react in a consistent direction through the earnings announcement.

B. Analysis Based on Double Sorts

It is possible that volatility or changes in volatility (the second moment) may be affecting our results. It is natural for implied volatility to increase prior to earnings announcements because of the impending uncertainty. As noted with the discussion of Table 1 results, kurtosis is defined as the fourth moment divided by the squared second moment; thus, volatility and kurtosis may be inversely related. Further, skewness is defined as the third moment divided by the second moment, raised to the 1.5 power; so, skewness and volatility may be inversely related. Therefore, to correctly identify the impacts of the third and fourth moments, the second moment needs to be controlled for. If the positive relation of skewness and kurtosis changes with future returns is caused by the second moment, then once it is controlled for, these relations should vanish.

We employ a double-sorting procedure to control for volatility and volatility changes. Each month we sort stocks into quintiles based on either implied volatility changes. Volatility is calculated as the moneyness weighted implied volatility for options where ATM options receive the most weight. Then we further sort stocks into quintiles based on either implied skewness or kurtosis changes. Skewness, kurtosis, and volatility changes are measured over the same three intervals studied before, (-30,-5), (-30,-10), and (-30,-20). Volatility levels are observed at days -5, -10, and -20. Equal-weighted portfolio BHRs are examined over periods (-4,1), (-9,1), and (-19,1), like before. Mean BHRs are provided in Table 4, Panel A, for implied skewness changes and Panel B for implied kurtosis changes. High minus low BHRs are also presented.

Skewness results are robust to volatility controls. The difference in BHRs between high and low skewness change quintiles is positive for all volatility and volatility change quintiles across all return periods, and significant for all but one volatility change quintile. However, the BHR differences are greatest in the high volatility and volatility change quintiles. The results for kurtosis are similar to those for skewness. All volatility quintiles and all but one of the volatility change quintiles have positive high minus BHRs; most are statistically significant. This shows that the positive and significant relation between kurtosis and future returns is maintained after controlling for volatility effects. Similar to skewness, the BHR differences based on kurtosis are greatest in the high volatility and volatility change quintiles. Thus, implied volatility levels and changes are not responsible for our detected ability of option prices to incorporate information about upcoming earnings announcements through implied skewness and kurtosis changes.

We next investigate whether the strong implied skewness and kurtosis relations we have found are unique effects or if one subsumes the other. Each month we sort stocks into quintiles based on implied skewness changes and then into quintiles based on implied kurtosis changes. This enables us to see if kurtosis changes matter after controlling for skewness changes. We then sort first on kurtosis change and then on skewness change, allowing us to determine if skewness change matters after controlling for kurtosis change. The same change periods are used as before. BHRs are examined for the same subsequent periods as previously. They are presented in Table 5, with the skewness change first sorts in Panel A and the kurtosis change first sorts in Panel B.

In Panel A, BHRs for high minus low kurtosis change quintiles are negative, but mostly insignificant, for the three lowest skewness change quintiles, but positive and generally significant (at the 5% level or better) for the two highest skewness change quintiles. In Panel B, BHRs for high minus low skewness change quintiles are positive for all kurtosis change quintiles, but the relation tends to be strongest for the higher kurtosis change quintiles. Thus, results in Table 5 suggest that both implied skewness and kurtosis have the ability to independently predict BHRs through earnings announcements, but the information content seems to be concentrated in higher skewness change and kurtosis change stocks. In the lower two skewness change quintiles, the BHRs for the high minus low kurtosis change quintiles are negative, but generally insignificant. The negative relation is not unexpected because low skewness change stocks are likely associated with bad news. For these firms high kurtosis change stocks should do worse than low kurtosis change stocks.

C. Option Returns

Since there is substantial evidence that changes in implied skewness and kurtosis imbedded in option prices can predict stock returns, we next examine if they can also predict call and put returns. We measure skewness and kurtosis changes and subsequent returns over the same three periods as in prior analyses. Option returns are weighted according to midpoint prices and are calculated by buying at the ask price and selling at the bid. Equal-weighted BHRs for skewness and kurtosis change quintiles and for the high minus low quintiles are calculated, with means and medians presented in Table 6.[14] BHRs are shown for ATM and OTM calls and puts. ATM options have the ratio of the stock price to the exercise price between 0.95 and 1.05. OTM calls (puts) have the same ratio greater than 1.1 (less than 0.9). BHRs following skewness changes are in Panel A and those following kurtosis changes are in Panel B.

For all categories of call (put) options, high minus low skewness and kurtosis changes have positive (negative) BHRs. For call options all high minus low differences are significant at the 5% level or higher. For put options, all high minus low skewness change differences are significant at the 1% level. With OTM put options, all high minus low kurtosis change differences are significant at the 1% level, whereas for ATM options half the differences are significant at the 5% level or better. The results strongly support the hypothesis that information about future earnings announcements, as reflected through implied skewness and kurtosis, can predict future option returns. These findings are consistent with those found for the prediction of stock returns.

D. Regressions

As our final analysis, we examine if the ability of implied skewness and kurtosis to predict stock and option returns disappears after controlling for common cross-sectional return predictors. We estimate cross-sectional regressions of stock and option returns on the market value of equity (SIZE), book-to-market equity (BM), momentum (MOM), and day -5, -10, or -20 moneyness weighted implied volatility (IV), implied

[14] Medians are examined because option returns are highly skewed.

skewness (SKEW), and implied kurtosis (KURT).[15] Other independent variables include the change from day -30 to day -5, -10, or -20 in implied volatility (ΔIV), implied skewness ($\Delta SKEW$), and implied kurtosis ($\Delta KURT$), and the interaction of $\Delta SKEW$ and $\Delta KURT$ ($\Delta SKEWKURT$). Regressions include dummy variables controlling for firms. BHRs for stock and ATM call and put options, over the periods (-4,1), (-9,1), and (-19,1) are the dependent variables.[16] Option BHRs are weighted according to the midpoint price and are calculated by buying at the ask price and selling at the bid. Regression estimation results are in Table 7, with Panel A for stock, Panel B for calls, and Panel C for puts. The empirical specifications is,

$$R_{HPR,i} = \alpha + \beta_1 SIZE_i + \beta_2 BM_i + \beta_3 MOM_i + \beta_4 IV_i + \beta_5 \Delta IV_i + \beta_6 SKEW_i + \beta_7 \mathrm{KURT}_i + \beta_8 \Delta SKEW_i + \beta_9 \Delta \mathrm{KURT}_i + \beta_{10} \Delta SKEWKURT_i + \varepsilon_i \quad (13)$$

where $R_{HPR,i}$ is the BHR for either the stock, call, or put for firm *i*. The first model restricts $\beta_4, \beta_5, \beta_6, \beta_7, \beta_8, \beta_9, \beta_{10} = 0$, the second model restricts $\beta_9, \beta_{10} = 0$, the third model restricts $\beta_8, \beta_{10} = 0$, the fourth model restricts $\beta_8, \beta_9 = 0$, and the fifth model has no restrictions.

For the stock regressions, $\Delta SKEW$, $\Delta KURT$, and $\Delta SKEWKURT$ tend to have positive and significant relations with future BHRs. This is always true when one of the three is in the model without the presence of the other two and is typically true when all three are included together, despite possible collinearity between the measures. The three variables are important despite the inclusion of ΔIV, which itself is typically a positive and significant explanatory variable. There is also evidence that IV, SKEW, and KURT have a significantly positive effect on BHRs, especially for the two longer holding periods. Thus, results in Panel A confirm prior evidence of the ability of changes in implied skewness and kurtosis to predict stock returns preceding and at earnings announcements.

Call regression results, in Panel B, are similar to those for stock. $\Delta SKEW$, $\Delta KURT$, and $\Delta SKEWKURT$ tend to have positive relations with call BHRs. The relation

[15] The market value of equity is measured at the end of the month prior to day -30. Book equity is measured as in Fama and French (1992) and momentum is measured as returns over the prior 12 months.
[16] OTM options provide similar results.

is always significant for $\Delta SKEW$ and significant all but one time for $\Delta KURT$. $\Delta SKEWKURT$ has a significant effect on the longest period BHRs, but it tends to weaken as the holding period shortens. The control variable ΔIV tends to affect BHRs for the shortest holding period while IV tends to affect BHRs for the longer periods. Consistent with stock return patterns and after controlling for implied volatility, call option prices, through implied skewness and kurtosis contain information about future earnings announcements.

Put regression results, in Panel C, are slightly weaker than for stock and call returns. In the shortest holding period, implied skewness and kurtosis are not significantly related to future BHRs. $\Delta SKEW$ is an important explanatory variable for the longer two holding periods. The coefficient on $\Delta KURT$ is significant only for the longest holding period. $\Delta SKEWKURT$ is a significant explanatory variable in the middle-length holding period, probably due to the influence of $\Delta SKEW$. Implied volatility and volatility changes tend to be significant control variables. Thus, information about future earnings is present in put prices prior to the announcement, mainly as reflected in implied skewness. This implies the effect of skewness and kurtosis changes impacts call and put prices differently.

IV. Conclusion

We examine whether information about future earnings announcements is embedded in option prices, through implied skewness and kurtosis, prior to the announcement. Skewness should capture the anticipated direction of the information, or future stock move, while kurtosis should reflect the anticipated magnitude of the information, or size of the stock jump. We initially link the changes in skewness and kurtosis to changes in jump size and intensity premiums, respectively. The simulation evidence provides an intuitive link between the underlying data generating process and how option markets can capture information before stock markets.

To test whether implied skewness and kurtosis can capture a jump event, measures of implied skewness and kurtosis calculated, from Bakshi, Kapadia, and Madan (2003), are applied to 74,027 earnings announcements made by 4,746 firms. We examine BHRs following the skewness and kurtosis changes through the earnings announcement.

Our portfolio analysis shows that both implied skewness and kurtosis changes strongly predict future stock returns through the earnings announcement. The predictive ability is stronger for options expiring soon after the announcement than for later maturity options. Skewness and kurtosis changes can predict future stock returns across all levels of and changes in implied volatility. The ability of implied kurtosis changes to predict stock returns is primarily confined to stocks with greater changes in implied skewness. Similarly, the ability of skewness changes to predict stock returns is weaker for low kurtosis change stocks. Thus, the strongest stock return predictive ability is associated with higher skewness and kurtosis change stocks. Skewness and kurtosis changes also strongly predict returns for ATM and OTM call and put returns.

Finally, using individual firm's stock and options, we cross-sectionally regress BHRs on changes in implied skewness and kurtosis, an interaction of the two changes, and a set of control variables. For stock and call options, we find that changes in implied skewness and kurtosis are strongly related to subsequent returns. For put option returns we find that skewness change is an important explanatory variable, but kurtosis changes have a very weak effect.

Overall our results show that over a period of time prior to earnings announcements, implied skewness and kurtosis changes are strongly related to future stock and option returns through the earnings announcement date. This indicates that informed traders affect option prices before the public announcement and in a manner that predicts future stock and option returns. Our results suggest that identifying implied skewness and kurtosis changes prior to earnings announcements may be profitable for investors and reflective of market inefficiency. It remains to be seen if such opportunities exist for other anticipated events.

Appendix A: Expressions for Risk-Neutral Skewness

The model-free estimates of risk-neutral skewness are based on Bakshi, Kapadia and Madan (2003). Let $R(t,\tau) \equiv \log(S_{t+\tau} - \log(S_t)$ and $\mu(t,\tau) \equiv E^Q\{R(t,\tau)\}$.

SKEW is defined as:

$$SKEW \equiv \frac{E^Q\{(R(t,\tau)-\mu(t,\tau))^3\}}{(E^Q\{(R(t,\tau)-\mu(t,\tau))^2\})^3} = \frac{e^{r\tau}W(t,\tau) - 3\mu(t,\tau)e^{r\tau}\nu(t,\tau) + 2\mu(t,\tau)^2}{\left(e^{r\tau}\nu(t,\tau) - \mu(t,\tau)^2\right)^{\frac{3}{2}}} \qquad \text{(A.1)}$$

and KURT is equal to:

$$KURT \equiv \frac{E^Q\{(R(t,\tau)-\mu(t,\tau))^4\}}{(E^Q\{(R(t,\tau)-\mu(t,\tau))^2\})^2}$$
$$= \frac{e^{r\tau}X(t,\tau) - 4\mu(t,\tau)e^{r\tau}W(t,\tau) + 6e^{r\tau}\mu(t,\tau)^2\nu(t,\tau) - 3\mu(t,\tau)^4}{\left(e^{r\tau}\nu(t,\tau) - \mu(t,\tau)^2\right)^2} \qquad \text{(A.2)}$$

where

$$\nu(t,\tau) = \int_{S_t}^{\infty} \frac{2\left(1 - \log\left[\frac{K}{S_t}\right]\right)}{K^2} C_t(\tau;K)dK + \int_0^{S_t} \frac{2\left(1 + \log\left[\frac{S_t}{K}\right]\right)}{K^2} P_t(\tau;K)dK, \qquad \text{(A.3)}$$

where r is the risk free interest rate, t is the time today, τ is the time at expiration, K is the strike price, S is the current stock price, C is the call price and P is the put price. The price of the cubic and quartic contracts are

$$W(t,\tau) = \int_{S_t}^{\infty} \frac{6\log\left[\frac{K}{S_t}\right] - 3\left(\log\left[\frac{K}{S_t}\right]\right)^2}{K^2} C_t(\tau;K)dK - \int_0^{S_t} \frac{6\log\left[\frac{S_t}{K}\right] + 3\left(\log\left[\frac{S_t}{K}\right]\right)^2}{K^2} P_t(\tau;K)dK, \qquad \text{(A.4)}$$

$$X(t,\tau) = \int_{S_t}^{\infty} \frac{12\left(\log\left[\frac{K}{S_t}\right]\right)^2 - 4\left(\log\left[\frac{K}{S_t}\right]\right)^3}{K^2} C_t(\tau;K)dK - \int_0^{S_t} \frac{12\left(\log\left[\frac{S_t}{K}\right]\right)^2 + 4\left(\log\left[\frac{S_t}{K}\right]\right)^3}{K^2} P_t(\tau;K)dK. \qquad \text{(A.5)}$$

Finally,

$$\mu(t,\tau) \equiv e^{r\tau} - 1 - \frac{e^{r\tau}}{2}\nu(t,\tau) - \frac{e^{r\tau}}{6}W(t,\tau) - \frac{e^{r\tau}}{24}X(t,\tau). \qquad \text{(A.6)}$$

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Table 1: Descriptive statistics for buy-and-hold return deciles over days (0,1)

The sample is divided into deciles based on buy-and-hold returns (BHRs) over days (0,1). Day 0 is the earnings announcement day. Mean values for BHRs and implied skewness, kurtosis, and volatility at days -5, -10, -20, and -30 are reported. Panel A gives skewness, kurtosis, and volatility levels while Panel B reports changes in these measures compared to day -30. Skewness and kurtosis are calculated as in Bakshi, Kapadia, and Madan (2003). * is significant at the 5% level and ** is significant at the 1% level.

Panel A: Levels

	Buy and Hold Return (0,1) Decile										
	Low	2	3	4	5	6	7	8	9	High	High-Low
BHR (0,1)	-0.110	-0.045	-0.025	-0.012	-0.002	0.007	0.017	0.032	0.057	0.125	0.235**
Skewness (-5)	-0.088	-0.178	-0.206	-0.256	-0.262	-0.256	-0.233	-0.184	-0.099	0.080	0.168**
Skewness (-10)	-0.060	-0.120	-0.204	-0.253	-0.263	-0.256	-0.239	-0.202	-0.139	0.016	0.075**
Skewness (-20)	-0.096	-0.167	-0.253	-0.247	-0.271	-0.276	-0.245	-0.224	-0.19	-0.047	0.049*
Skewness (-30)	-0.084	-0.162	-0.230	-0.237	-0.247	-0.259	-0.231	-0.223	-0.171	-0.067	0.017
Kurtosis (-5)	4.49	4.59	4.78	4.86	4.84	4.89	4.87	4.81	4.74	4.72	0.24**
Kurtosis (-10)	4.43	4.56	4.72	4.75	4.72	4.81	4.74	4.69	4.59	4.55	0.12*
Kurtosis (-20)	4.07	4.24	4.31	4.47	4.45	4.50	4.45	4.34	4.26	4.13	0.06
Kurtosis (-30)	3.87	3.99	4.14	4.24	4.24	4.29	4.28	4.14	4.04	3.89	0.02
Volatility (-5)	0.642	0.585	0.558	0.537	0.531	0.528	0.541	0.556	0.583	0.643	0.000
Volatility (-10)	0.620	0.566	0.535	0.515	0.510	0.506	0.517	0.532	0.559	0.617	-0.004
Volatility (-20)	0.597	0.541	0.509	0.487	0.482	0.480	0.490	0.507	0.533	0.592	-0.005
Volatility (-30)	0.580	0.525	0.492	0.470	0.465	0.462	0.473	0.489	0.517	0.573	-0.007

Panel B: Changes

	Low	2	3	4	5	6	7	8	9	High	High-Low
Skewness Change (-30,-5)	-0.004	-0.016	0.024	-0.019	-0.015	0.003	-0.002	0.039	0.072	0.148	0.151**
Skewness Change (-30,-10)	0.025	0.041	0.025	-0.016	-0.016	0.003	-0.008	0.021	0.032	0.083	0.058**
Skewness Change (-30,-20)	-0.012	-0.005	-0.023	-0.01	-0.024	-0.017	-0.015	-0.001	-0.019	0.02	0.032*
Kurtosis Change (-30,-5)	0.62	0.60	0.64	0.62	0.60	0.60	0.59	0.67	0.71	0.84	0.22**
Kurtosis Change (-30,-10)	0.57	0.57	0.57	0.51	0.48	0.52	0.46	0.55	0.56	0.66	0.10**
Kurtosis Change (-30,-20)	0.20	0.24	0.17	0.23	0.21	0.20	0.17	0.20	0.22	0.24	0.04*
Volatility Change (-30,-5)	0.061	0.060	0.063	0.063	0.062	0.065	0.063	0.063	0.064	0.067	0.006
Volatility Change (-30,-10)	0.040	0.040	0.042	0.042	0.041	0.043	0.042	0.041	0.043	0.043	0.002
Volatility Change (-30,-20)	0.016	0.015	0.017	0.017	0.017	0.018	0.016	0.017	0.016	0.017	0.001

Table 2: Implied skewness and kurtosis changes by option expiration

Firms are divided into quintiles monthly according to buy-and-hold returns (BHRs). In Panels A and B firms are divided according to BHRs over days (-4,1) with skewness and kurtosis changes reported over days (-30,-5). In Panels C and D firms are divided according to BHRs over days (-9,1) with skewness and kurtosis changes reported over days (-30,-10). In Panels E and F firms are divided according to BHRs over days (-19,1) with skewness and kurtosis changes reported over days (-30,-20). Skewness and kurtosis are calculated as in Bakshi, Kapadia, and Madan (2003). Results are reported separately for options with the next expiration date (month t) and the following expiration date (month t+1). The difference of the absolute values of skewness and kurtosis between the maturities is reported for each panel. * is significant at the 5% level and ** is significant at the 1% level.

Panel A:		Return (-4,1) Quintile				
Skewness Change (-30,-5)		Low	2	3	4	High
Expiration	ΔMonth t	-0.040	-0.019	0.020	0.035	0.149
	ΔMonth t+1	-0.012	-0.004	0.010	0.052	0.102
	ABS(Δt)-ABS(Δt+1)	0.028	0.014	0.009	-0.017	0.047
Panel B:		Return (-4,1) Quintile				
Kurtosis Change (-30,-5)		Low	2	3	4	High
Expiration	ΔMonth t	0.659	0.709	0.734	0.744	0.871
	ΔMonth t+1	0.291	0.263	0.333	0.338	0.514
	ABS(Δt)-ABS(Δt+1)	0.369**	0.446**	0.401**	0.406**	0.357**
Panel C:		Return (-9,1) Quintile				
Skewness Change (-30,-10)		Low	2	3	4	High
Expiration	ΔMonth t	-0.051	-0.048	0.013	0.017	0.142
	ΔMonth t+1	-0.026	-0.014	0.028	0.065	0.120
	ABS(Δt)-ABS(Δt+1)	0.025	0.034	-0.014	-0.048	0.023
Panel D:		Return (-9,1) Quintile				
Kurtosis Change (-30,-10)		Low	2	3	4	High
Expiration	ΔMonth t	0.434	0.528	0.556	0.569	0.686
	ΔMonth t+1	0.249	0.232	0.276	0.336	0.463
	ABS(Δt)-ABS(Δt+1)	0.185**	0.296**	0.281**	0.233**	0.223**
Panel E:		Return (-19,1) Quintile				
Skewness Change (-30,-20)		Low	2	3	4	High
Expiration	ΔMonth t	-0.084	-0.077	-0.030	0.006	0.063
	ΔMonth t+1	-0.071	-0.045	-0.006	0.039	0.071
	ABS(Δt)-ABS(Δt+1)	0.013	0.032	0.024	-0.033	-0.007
Panel F:		Return (-19,1) Quintile				
Kurtosis Change (-30,-20)		Low	2	3	4	High
Expiration	ΔMonth t	0.217	0.249	0.276	0.321	0.359
	ΔMonth t+1	0.053	0.113	0.167	0.193	0.263
	ABS(Δt)-ABS(Δt+1)	0.164**	0.137**	0.109**	0.129**	0.096*

Table 3: Stock returns following implied skewness and kurtosis changes

In Panel A (B) firms are divided into quintiles monthly according to implied skewness (kurtosis) changes over days (-30,-5), (-30,-10), and (-30,-20), and equal-weighted buy-and hold returns (BHRs) are examined over periods (-4,1), (-9,1), and (-19,1), respectively. Day 0 is the earnings announcement date. Mean values over the sample period for daily BHRs and skewness and kurtosis changes are presented. The differences for BHRs between high and low quintiles are given, with t-statistics in parentheses. Skewness and kurtosis are calculated as in Bakshi, Kapadia, and Madan (2003).

Panel A: Skewness	Skewness Change Days (-30,-5)		Skewness Change Days (-30-10)		Skewness Change Days(-30,-20)	
Change Quintile	BHR (-4,1)	Skewness Change	BHR (-9,1)	Skewness Change	BHR (-19,1)	Skewness Change
Low 1	0.040	-1.741	0.038	-1.640	0.015	-1.385
2	0.069	-0.469	0.030	-0.420	0.022	-0.318
3	0.136	-0.014	0.084	-0.012	0.046	-0.008
4	0.133	0.474	0.103	0.424	0.079	0.307
High 5	0.243	1.960	0.162	1.782	0.112	1.395
High-Low	0.203		0.124		0.097	
	(8.73)		(8.12)		(9.05)	

Panel B: Kurtosis	Kurtosis Change Days (-30,-5)		Kurtosis Change Days (-30-10)		Kurtosis Change Days (-30,-20)	
Change Quintile	BHR (-4,1)	Kurtosis Change	BHR (-9,1)	Kurtosis Change	BHR (-19,1)	Kurtosis Change
Low 1	0.089	-2.022	0.066	-1.979	0.036	-1.785
2	0.100	-0.091	0.073	-0.112	0.043	-0.130
3	0.105	0.320	0.061	0.239	0.040	0.120
4	0.102	1.050	0.053	0.842	0.046	0.515
High 5	0.209	4.251	0.153	3.677	0.096	2.635
High-Low	0.120		0.087		0.060	
	(5.25)		(5.70)		(5.61)	

Table 4: Stock returns following sorting by volatility and then either implied skewness or kurtosis changes

Firms are divided into quintiles monthly according to volatility or volatility changes and then divided into quintiles based on implied skewness (Panel A) or kurtosis (Panel B) changes. Volatility, skewness, and kurtosis changes are measured over days (-30,-5), (-30,-10), and (-30,-20). Volatility levels are measured on days -5, -10, and -20. Subsequent equal-weighted portfolio buy-and-hold returns (BHRs) are examined for the periods (-4,1), (-9,1), and (-19,1), respectively. Day 0 is the earnings announcement date. Mean values for daily BHRs. The differences for BHRs between high and low quintiles are reported, with t-statistics in parentheses. Skewness and kurtosis are calculated as in Bakshi, Kapadia, and Madan (2003). Volatility is calculated as the moneyness weighted implied volatility for options where ATM options receive the most weight.

Panel A: Skewness Change

BHR (-4,1)		Volatility Quintile (-5)					Volatility Change Quintile (-30,-5)				
		Low	2	3	4	High	Low	2	3	4	High
Skewness Change Quintile (-30,-5)	Low 1	0.049	0.114	0.003	0.035	0.006	-0.077	0.030	0.044	0.109	0.130
	2	0.003	0.100	0.088	0.134	0.046	0.008	0.034	0.103	0.160	0.124
	3	0.064	0.098	0.120	0.209	0.105	0.050	0.102	0.140	0.184	0.219
	4	0.108	0.097	0.202	0.132	0.099	0.057	0.117	0.123	0.147	0.237
	High 5	0.147	0.297	0.251	0.280	0.323	0.109	0.184	0.237	0.273	0.322
	High-Low	0.097	0.183	0.248	0.245	0.317	0.187	0.154	0.194	0.164	0.192
		(2.93)	(4.29)	(5.20)	(4.28)	(4.35)	(3.43)	(3.24)	(4.06)	(3.25)	(3.25)

BHR (-9,1)		Volatility Quintile (-10)					Volatility Change Quintile (-30,-10)				
		Low	2	3	4	High	Low	2	3	4	High
Skewness Change Quintile (-30,-10)	Low 1	0.027	0.028	0.036	0.085	0.006	-0.014	0.029	0.055	0.054	0.093
	2	-0.017	0.036	0.017	0.063	0.072	0.002	0.025	0.004	0.054	0.107
	3	0.027	0.054	0.089	0.129	0.059	0.045	0.108	0.079	0.088	0.101
	4	0.086	0.118	0.095	0.113	0.108	0.042	0.095	0.116	0.116	0.154
	High 5	0.111	0.192	0.155	0.187	0.209	0.040	0.146	0.174	0.176	0.236
	High-Low	0.083	0.164	0.119	0.102	0.203	0.054	0.117	0.120	0.122	0.143
		(4.01)	(6.26)	(3.81)	(2.62)	(4.09)	(1.49)	(3.72)	(3.94)	(3.77)	(3.53)

BHR (-19,1)		Volatility Quintile (-20)					Volatility Change Quintile (-30,-20)				
		Low	2	3	4	High	Low	2	3	4	High
Skewness Change Quintile (-30,-20)	Low 1	0.011	0.026	0.030	0.009	-0.006	-0.035	0.021	0.009	0.052	0.051
	2	0.008	0.026	0.017	0.047	0.014	0.000	-0.002	0.016	0.053	0.067
	3	-0.001	0.017	0.047	0.080	0.061	0.031	0.018	0.040	0.054	0.098
	4	0.029	0.063	0.074	0.087	0.135	0.058	0.048	0.076	0.078	0.106
	High 5	0.057	0.115	0.122	0.132	0.140	0.079	0.097	0.091	0.112	0.154
	High-Low	0.046	0.088	0.093	0.123	0.147	0.114	0.077	0.082	0.060	0.102
		(3.30)	(4.78)	(4.26)	(4.53)	(4.11)	(4.42)	(3.53)	(3.81)	(2.64)	(3.52)

Panel B: Kurtosis Change

BHR (-4,1)		Volatility Quintile (-5)					Volatility Change Quintile (-30,-5)				
		Low	2	3	4	High	Low	2	3	4	High
Kurtosis Change Quintile (-30,-5)	Low 1	0.052	0.107	0.101	0.103	0.027	0.007	0.071	0.073	0.150	0.140
	2	0.055	0.086	0.112	0.098	0.088	0.039	0.044	0.120	0.150	0.197
	3	0.064	0.117	0.078	0.229	0.085	0.079	0.114	0.104	0.135	0.163
	4	0.043	0.090	0.114	0.145	0.102	0.051	0.009	0.101	0.167	0.168
	High 5	0.129	0.278	0.245	0.232	0.292	0.067	0.170	0.170	0.226	0.317
	High-Low	0.077	0.171	0.144	0.129	0.265	0.060	0.099	0.097	0.076	0.178
		(2.72)	(4.36)	(3.06)	(2.18)	(3.25)	(1.06)	(2.11)	(2.06)	(1.60)	(3.11)

BHR (-9,1)		Volatility Quintile (-10)					Volatility Change Quintile (-30,-10)				
		Low	2	3	4	High	Low	2	3	4	High
Kurtosis Change Quintile (-30,-10)	Low 1	0.018	0.061	0.055	0.125	0.066	0.051	0.051	0.078	0.074	0.118
	2	0.013	0.022	0.089	0.090	0.102	0.018	0.063	0.049	0.075	0.110
	3	0.032	0.072	0.044	0.084	0.091	0.075	0.061	0.034	0.095	0.078
	4	0.014	0.082	0.066	0.092	0.030	-0.006	0.053	0.068	0.078	0.108
	High 5	0.120	0.164	0.154	0.188	0.230	0.019	0.137	0.163	0.176	0.223
	High-Low	0.102	0.104	0.099	0.063	0.164	-0.032	0.086	0.084	0.102	0.105
		(5.49)	(4.22)	(3.21)	(1.59)	(2.90)	(0.88)	(2.80)	(2.80)	(3.23)	(2.63)

BHR (-19,1)		Volatility Quintile (-20)					Volatility Change Quintile (-30,-20)				
		Low	2	3	4	High	Low	2	3	4	High
Kurtosis Change Quintile (-30,-20)	Low 1	0.015	0.055	0.042	0.035	0.026	0.000	0.019	0.025	0.077	0.068
	2	0.017	0.032	0.052	0.050	0.043	0.019	0.043	0.044	0.054	0.060
	3	0.006	0.020	0.029	0.079	0.021	0.022	0.027	0.014	0.049	0.089
	4	0.007	0.048	0.059	0.070	0.082	0.051	0.007	0.045	0.069	0.086
	High 5	0.037	0.098	0.107	0.139	0.174	0.040	0.066	0.084	0.090	0.164
	High-Low	0.022	0.043	0.065	0.103	0.148	0.040	0.047	0.059	0.014	0.097
		(1.75)	(2.54)	(3.08)	(3.71)	(3.70)	(1.50)	(2.18)	(2.82)	(0.63)	(3.39)

Table 5: Stock returns following double sorting by implied skewness and kurtosis changes

Firms are double sorted into quintiles monthly by skewness and kurtosis changes over days (-30,-5), (-30,-10), and (-30,-20). In Panel A firms are first sorted by skewness change, then kurtosis change. In Panel B firms are first sorted by kurtosis change, then skewness change. Mean values for buy-and-hold returns (BHRs) over return periods (-4,1), (-9,1), and (-19,1), respectively, are presented. The differences in BHRs between high and low quintiles are provided, with t-statistics in parentheses. Skewness and kurtosis are calculated as in Bakshi, Kapadia, and Madan (2003).

Panel A:

BHR (-4,1)		Skewness Change Quintile				
		Low	2	3	4	High
	Low 1	0.082	0.124	0.124	0.068	0.178
Kurtosis Change Quintile	2	0.041	0.080	0.162	0.214	0.234
	3	0.079	0.113	0.154	0.088	0.180
	4	0.034	0.078	0.099	0.093	0.253
	High 5	-0.009	0.014	0.112	0.188	0.334
	High-Low	-0.090	-0.110	-0.011	0.120	0.156
		(1.79)	(2.12)	(0.21)	(2.19)	(2.78)

BHR (-9,1)		Skewness Change Quintile				
		Low	2	3	4	High
	Low 1	0.078	0.079	0.097	0.089	0.082
Kurtosis Change Quintile	2	0.037	0.050	0.129	0.092	0.081
	3	0.036	0.038	0.092	0.080	0.179
	4	0.027	0.035	0.060	0.102	0.190
	High 5	0.014	0.023	0.054	0.124	0.240
	High-Low	-0.064	-0.057	-0.043	0.035	0.159
		(1.96)	(1.64)	(1.20)	(0.91)	(4.23)

BHR (-19,1)		Skewness Change Quintile				
		Low	2	3	4	High
	Low 1	0.022	0.053	0.071	0.046	0.063
Kurtosis Change Quintile	2	0.034	0.062	0.033	0.061	0.090
	3	0.013	0.003	0.039	0.054	0.075
	4	0.008	0.023	0.042	0.070	0.140
	High 5	-0.002	0.007	0.061	0.099	0.177
	High-Low	-0.024	-0.045	-0.010	0.052	0.114
		(1.05)	(1.88)	(0.38)	(2.03)	(4.37)

Panel B:

BHR (-4,1)		Kurtosis Change Quintile				
		Low	2	3	4	High
	Low 1	0.047	0.029	0.107	-0.004	0.061
Skewness Change Quintile	2	0.104	0.068	0.089	0.088	0.192
	3	0.034	0.120	0.097	0.136	0.309
	4	0.150	0.145	0.135	0.183	0.179
	High 5	0.095	0.142	0.134	0.142	0.352
	High-Low	0.049	0.113	0.027	0.145	0.291
		(0.89)	(2.37)	(0.59)	(2.99)	(5.14)

BHR (-9,1)		Kurtosis Change Quintile				
		Low	2	3	4	High
	Low 1	0.035	0.024	0.043	0.006	0.055
Skewness Change Quintile	2	0.076	0.053	0.023	0.028	0.132
	3	0.038	0.096	0.071	0.114	0.146
	4	0.067	0.124	0.103	0.088	0.220
	High 5	0.099	0.095	0.079	0.061	0.248
	High-Low	0.063	0.071	0.037	0.055	0.193
		(1.75)	(2.28)	(1.21)	(1.76)	(4.96)

BHR (-19,1)		Kurtosis Change Quintile				
		Low	2	3	4	High
	Low 1	0.027	0.018	0.016	0.000	0.022
Skewness Change Quintile	2	0.009	0.025	0.020	0.032	0.092
	3	0.031	0.080	0.047	0.062	0.115
	4	0.026	0.034	0.066	0.083	0.121
	High 5	0.075	0.062	0.062	0.075	0.154
	High-Low	0.048	0.044	0.046	0.075	0.132
		(1.91)	(1.97)	(2.16)	(3.37)	(4.95)

Table 6: Option returns following implied skewness and kurtosis changes

In Panel A (B) firms are divided into quintiles monthly according to implied skewness (kurtosis) changes over days (-30,-5), (-30,-10), and (-30,-20), and equal-weighted buy-and hold returns (BHRs) are examined over periods (-4,1), (-9,1), and (-19,1), respectively. Day 0 is the earnings announcement date. Option returns are weighted according to midpoint price and calculated by buying at the ask price and selling at the bid. Results are reported for ATM and OTM call and put options. ATM options have the ratio of the stock price to the exercise price .95 and 1.05. OTM call (put) options have this ratio greater than 1.1 (less than0.9). The differences for mean (median) BHRs between high and low quintiles are given, with t-statistics (z-statistics) in parentheses. Skewness and kurtosis are calculated as in Bakshi, Kapadia, and Madan (2003).

Panel A: Skewness Change

	Call ATM		Call OTM		Put ATM		Put OTM	
Skewness Change (-30,-5), BHR (-4,1)								
Low 1	-7.80	-24.24	-6.85	-8.24	-9.45	-25.00	-7.34	-8.33
2	-5.39	-20.00	-5.72	-7.84	-11.52	-25.24	-8.20	-8.62
3	-4.18	-20.00	-5.33	-7.35	-10.06	-26.79	-8.03	-8.77
4	-4.95	-21.51	-5.17	-7.32	-12.01	-26.47	-8.36	-9.30
High 5	3.44	-16.67	-2.15	-5.33	-15.98	-30.43	-10.87	-10.87
High-Low	11.24	7.58	4.70	2.90	-6.53	-5.43	-3.53	-2.54
	(8.07)	(6.32)	(8.41)	(6.29)	(5.06)	(4.73)	(7.49)	(6.90)
Skewness Change (-30,-10), BHR (-9,1)								
Low 1	-8.26	-33.33	-7.00	-9.23	-9.65	-33.33	-7.77	-9.41
2	-7.74	-32.00	-6.64	-9.38	-9.47	-33.87	-7.90	-9.30
3	-3.73	-29.84	-4.62	-7.69	-11.96	-37.50	-8.85	-10.34
4	-0.43	-28.57	-3.18	-6.82	-13.42	-38.89	-10.24	-11.36
High 5	3.57	-26.67	-1.46	-5.26	-17.93	-41.38	-11.50	-12.20
High-Low	11.84	6.67	5.54	3.97	-8.28	-8.05	-3.73	-2.78
	(7.23)	(6.54)	(8.14)	(5.31)	(5.49)	(4.25)	(6.27)	(5.66)
Skewness Change(-30,-20), BHR (-19,1)								
Low 1	-10.77	-38.10	-8.44	-11.36	-12.09	-38.30	-8.68	-11.76
2	-12.97	-36.00	-8.81	-11.54	-8.66	-37.50	-7.42	-10.53
3	-9.10	-37.88	-7.33	-10.53	-10.90	-38.26	-8.73	-11.54
4	-8.82	-35.71	-5.20	-8.96	-12.14	-41.67	-10.25	-12.28
High 5	-3.91	-31.82	-3.91	-7.89	-16.44	-42.86	-11.90	-14.00
High-Low	6.87	6.28	4.53	3.47	-4.35	-4.56	-3.22	-2.24
	(4.45)	(3.77)	(5.99)	(5.55)	(2.99)	(3.95)	(4.80)	(5.42)

Panel B: Kurtosis Change

	Call ATM		Call OTM		Put ATM		Put OTM	
Kurtosis Change(-30,-5), BHR(-4,1)								
Low 1	-5.65	-22.22	-5.82	-7.55	-11.71	-25.64	-8.45	-8.82
2	-5.62	-22.73	-5.51	-7.14	-12.14	-25.81	-8.33	-8.75
3	-5.49	-21.67	-5.42	-6.82	-12.00	-28.57	-8.21	-8.89
4	-3.87	-21.43	-5.14	-6.72	-9.96	-25.71	-8.49	-9.38
High 5	0.40	-19.35	-3.32	-5.77	-13.88	-29.41	-10.05	-10.17
High-Low	6.06	2.87	2.49	1.78	-2.17	-3.77	-1.60	-1.35
	(4.48)	(5.10)	(4.45)	(5.33)	(1.71)	(2.56)	(3.45)	(4.60)
Kurtosis Change (-30,-10), BHR (-9,1)								
Low 1	-7.90	-33.33	-6.14	-9.30	-11.74	-34.00	-8.77	-10.00
2	-4.22	-31.48	-5.31	-7.89	-10.23	-35.71	-8.68	-9.76
3	-5.57	-30.61	-5.40	-7.50	-12.16	-38.46	-8.66	-9.80
4	-4.10	-30.43	-4.78	-7.22	-11.86	-34.29	-9.08	-10.42
High 5	2.48	-26.09	-2.34	-6.06	-16.17	-41.38	-11.98	-12.50
High-Low	10.37	7.25	3.80	3.24	-4.43	-7.38	-3.21	-2.50
	(6.41)	(6.02)	(5.61)	(4.87)	(3.01)	(3.56)	(5.54)	(5.28)
Kurtosis Change (-30,-20), BHR (-19,1)								
Low 1	-10.39	-37.84	-7.68	-11.30	-13.68	-40.00	-10.02	-12.50
2	-9.04	-36.84	-7.04	-9.43	-11.42	-40.00	-8.98	-11.72
3	-10.03	-35.42	-7.13	-9.20	-13.73	-39.29	-9.32	-11.32
4	-11.27	-37.93	-7.18	-9.89	-9.16	-36.54	-9.03	-12.24
High 5	-6.79	-35.59	-6.04	-9.76	-15.19	-39.71	-12.02	-13.56
High-Low	3.60	2.24	1.64	1.55	-1.50	0.29	-2.00	-1.06
	(2.36)	(2.03)	(2.21)	(2.81)	(1.05)	(0.48)	(3.05)	(3.94)

Table 7: Regression estimations

Stock and option buy-and-hold returns (BHR) are regressed on the market value of equity (SIZE), book-to-market equity (BM), momentum (MOM), day -30 moneyness weighted implied volatility (IV), implied volatility change (ΔIV), day -30 implied skewness (SKEW), day -30 implied kurtosis (KURT), skewness change ($\Delta SKEW$), kurtosis change ($\Delta KURT$), and the interaction of skewness and kurtosis changes ($\Delta SKEWKURT$). Stock and ATM option BHRs over the periods [-4,1], [-9,1], and [-19,1] are the dependent variables. Returns are weighted according to midpoint price and are calculated by buying at the ask price and selling at the bid. When day (-4,1), (-9,1), and (-19,1) BHRs are used, implied volatility, skewness and kurtosis changes are measured over periods (-30,-5), (-30,-10), and (-30,-20), respectively. Day 0 is the earnings announcement date. Coefficients are presented with t-statistics in parentheses. * is significant at the 5% level and ** is significant at the 1% level.

Panel A: Stock Returns

	BHR (-4,1)					BHR (-9,1)					BHR (-19,1)				
SIZE	-0.76	-0.65	-0.79	-0.72	-0.10	-0.93	0.59	0.39	0.65	-0.09	-1.11	0.70	0.40	0.66	0.17
	(1.42)	(0.99)	(1.21)	(1.11)	(0.41)	(2.67)**	(1.40)	(0.92)	(1.53)	(0.48)	(4.59)**	(2.46)*	(1.41)	(2.33)*	(0.09)
BM	0.05	0.01	0.01	0.02	0.03	0.04	0.08	0.09	0.12	0.09	0.04	0.09	0.10	0.12	0.04
	(0.53)	(0.09)	(0.16)	(0.23)	(0.29)	(0.60)	(1.13)	(1.39)	(1.86)	(1.43)	(1.02)	(1.92)	(2.35)*	(2.88)**	(1.09)
MOM	2.71	2.58	2.41	2.65	0.63	0.47	0.10	-0.57	0.01	-1.63	-2.22	-2.17	-2.45	-2.09	-3.10
	(2.11)*	(1.98)*	(1.85)	(2.03)*	(0.46)	(0.39)	(0.08)	(0.46)	(0.01)	(1.28)	(3.03)**	(2.98)**	(3.33)**	(2.85)**	(4.15)**
IV		-2.12	-1.48	-4.38	1.79		18.31	24.32	18.79	25.16		23.47	26.72	23.47	25.62
		(0.33)	(0.23)	(0.67)	(0.29)		(4.05)**	(5.40)**	(4.12)**	(5.72)**		(8.00)**	(9.23)**	(7.93)**	(9.00)**
ΔIV		15.20	16.83	18.57	44.27		26.42	30.32	36.97	45.29		39.76	44.79	58.75	37.69
		(1.60)	(1.77)	(1.96)*	(4.52)**		(3.43)**	(4.01)**	(4.85)**	(5.55)**		(5.26)**	(5.89)**	(7.46)**	(4.77)**
SKEW		1.48	0.38	0.01	2.17		3.37	1.65	0.49	2.72		3.41	1.83	0.76	3.38
		(1.80)	(0.49)	(0.01)	(2.46)*		(6.13)**	(3.22)**	(0.94)	(4.61)**		(9.16)**	(5.34)**	(2.11)*	(8.53)**
KURT		-0.48	-0.29	-0.67	-0.52		0.55	0.86	-0.02	0.99		1.11	1.25	0.51	1.19
		(0.94)	(0.56)	(1.33)	(0.99)		(1.63)	(2.60)**	(0.06)	(2.85)**		(4.89)**	(5.67)**	(2.29)*	(5.09)**
ΔSKEW		2.78			2.20		5.84			1.78		7.78			3.20
		(4.59)**			(2.25)*		(12.95)**			(2.48)*		(19.68)**			(5.79)**
ΔKURT			1.07		-0.25			3.02		2.02			3.65		1.74
			(2.81)**		(0.41)			(10.56)**		(4.27)**			(14.17)**		(4.41)**
ΔSKEW KURT				0.68	0.44				1.32	0.66				0.99	0.15
				(2.78)**	(1.58)				(6.29)**	(2.90)**				(4.62)**	(0.71)
INTERCEPT	0.90	0.93	0.93	1.05	0.54	1.89	-1.43	-1.75	-1.42	-0.44	3.70	-4.22	-4.13	-3.91	-0.52
	(2.27)*	(1.69)	(1.68)	(1.89)	(2.47)*	(3.69)**	(1.95)	(2.39)*	(1.93)	(2.92)**	(5.45)**	(4.58)**	(4.53)**	(4.26)**	(5.37)**

Panel B: Call Returns

	BHR (-4,1)					BHR (-9,1)					BHR (-19,1)				
SIZE	4.53	3.18	3.18	3.17	3.30	2.91	2.78	2.94	2.50	2.73	3.15	4.45	4.33	4.23	4.26
	(1.73)	(1.32)	(1.33)	(1.32)	(1.37)	(1.07)	(1.08)	(1.09)	(0.98)	(1.06)	(1.38)	(1.70)	(1.68)	(1.61)	-(1.63)
BM	-0.21	-0.22	-0.22	-0.22	-0.22	-0.23	-0.23	-0.22	-0.20	-0.23	-0.13	-0.11	-0.11	-0.10	-0.11
	(1.88)	(2.04)*	(2.06)*	(1.99)*	(2.08)*	(2.11)*	(2.31)*	(2.16)*	(1.98)*	(2.32)*	(1.85)	(1.62)	(1.51)	(1.44)	(1.59)
MOM	1.87	1.44	1.29	1.42	1.18	-0.55	-1.10	-1.13	-0.98	-1.20	-0.99	-1.01	-1.06	-0.80	-0.85
	(3.01)**	(2.26)*	(2.01)*	(2.22)*	(1.83)	(0.82)	(1.50)	(1.54)	(1.32)	(1.62)	(1.37)	(1.36)	(1.41)	(1.07)	(1.14)
IV		1.22	2.19	1.05	3.41		8.95	11.48	7.81	10.68		12.22	14.56	10.61	11.64
		(0.36)	(0.64)	(0.31)	(0.99)		(1.90)	(2.42)*	(1.61)	(2.19)*		(3.23)**	(3.89)**	(2.78)**	(3.01)**
ΔIV		18.02	16.76	20.44	17.14		14.32	15.09	22.03	13.28		9.69	16.20	19.41	7.53
		(3.08)**	(2.89)**	(3.50)**	(2.94)**		(1.64)	(1.68)	(2.43)*	(1.48)		(0.90)	(1.53)	(1.80)	(0.70)
SKEW		-1.75	-2.16	-2.31	-2.17		1.38	0.09	-0.50	0.99		3.55	2.81	1.64	3.19
		(2.84)**	(3.82)**	(4.12)**	(3.34)**		(1.91)	(0.14)	(0.76)	(1.34)		(5.41)**	(4.79)**	(2.74)**	(4.65)**
KURT		2.01	2.22	1.97	2.32		1.80	2.04	1.51	1.97		0.94	0.77	0.54	0.82
		(5.86)**	(6.39)**	(5.71)**	(6.52)**		(4.55)**	(5.07)**	(3.79)**	(4.78)**		(2.44)*	(1.97)*	(1.39)	(1.99)*
ΔSKEW		1.17			-0.29		4.02			2.52		4.78			3.72
		(2.47)*			(0.41)		(6.94)**			(3.08)**		(7.52)**			(4.23)**
ΔKURT			1.05		1.34			2.20		1.25			2.02		0.60
			(3.81)**		(3.32)**			(6.44)**		(2.50)*			(5.18)**		(1.05)
ΔSKEW KURT				-0.01	-0.28				0.41	-0.13				0.98	0.50
				(0.07)	(1.62)				(1.96)*	(0.54)				(3.71)**	(1.96)*
INTERCEPT	-6.95	-16.78	-18.76	-16.94	-19.95	-5.00	-16.03	-19.87	-15.44	-18.07	-12.06	-20.03	-21.89	-18.74	-19.42
	(9.54)**	(6.37)**	(7.04)**	(6.34)**	(7.15)**	(6.12)**	(4.95)**	(6.04)**	(4.65)**	(5.30)**	(16.20)**	(6.43)**	(7.03)**	(5.96)**	(5.84)**

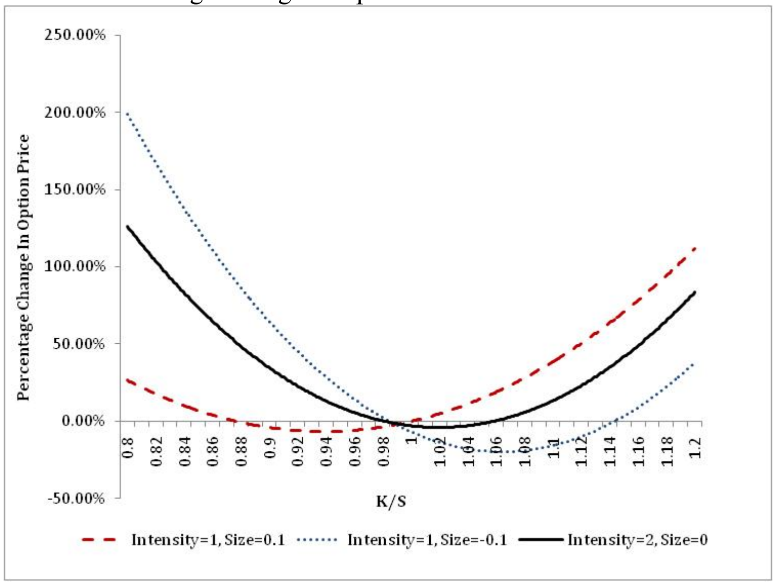
Panel C: Put Returns

	BHR (-4,1)					BHR (-9,1)					BHR (-19,1)				
SIZE	10.68	10.70	10.71	10.79	10.78	10.21	8.77	8.55	8.89	8.74	9.63	6.93	6.87	6.99	6.93
	(3.43)**	(3.47)**	(3.47)**	(3.49)**	(3.51)**	(3.62)**	(3.34)**	(3.25)**	(3.36)**	(3.35)**	(4.15)**	(3.28)**	(3.24)**	(3.28)**	(3.29)**
BM	-0.19	-0.16	-0.17	-0.17	-0.16	-0.24	-0.24	-0.25	-0.26	-0.24	-0.26	-0.27	-0.27	-0.28	-0.27
	(2.21)*	(2.09)*	(2.13)*	(2.15)*	(2.13)*	(2.47)*	(2.33)*	(2.51)*	(2.53)*	(2.35)*	(3.69)**	(3.88)**	(4.05)**	(4.09)**	(3.86)**
MOM	3.17	2.34	2.34	2.30	2.19	4.46	4.07	4.10	3.95	3.95	4.05	4.10	3.99	3.90	3.80
	(4.39)**	(3.25)**	(3.24)**	(3.20)**	(3.04)**	(5.47)**	(4.89)**	(4.86)**	(4.72)**	(4.73)**	(5.82)**	(5.83)**	(5.84)**	(5.67)**	(5.59)**
IV		17.25	17.41	17.99	18.50		3.94	2.81	4.52	3.91		-11.82	-13.64	-12.39	-11.93
		(5.57)**	(5.60)**	(5.75)**	(5.81)**		(1.19)	(0.84)	(1.33)	(1.14)		(3.82)**	(4.45)**	(3.95)**	(3.80)**
ΔIV		-14.83	-16.05	-15.33	-15.26		-30.28	-33.68	-34.66	-30.62		-37.30	-48.10	-46.88	-39.13
		(2.65)**	(2.85)**	(2.78)**	(2.71)**		(4.16)**	(4.50)**	(4.69)**	(4.09)**		(3.61)**	(4.66)**	(4.50)**	(3.74)**
SKEW		-3.15	-2.90	-2.86	-3.34		-4.45	-3.80	-3.29	-4.48		-4.64	-4.44	-3.35	-4.90
		(5.34)**	(5.30)**	(5.25)**	(5.37)**		(6.30)**	(5.97)**	(5.14)**	(5.86)**		(8.00)**	(8.40)**	(6.04)**	(8.01)**
KURT		1.85	1.88	1.89	2.01		1.63	1.82	1.81	1.79		0.55	1.04	0.77	0.85
		(5.52)**	(5.52)**	(5.63)**	(5.79)**		(4.22)**	(4.64)**	(4.60)**	(4.33)**		(1.75)	(3.24)**	(2.40)*	(2.58)**
ΔSKEW		-0.51			-1.24		-2.33			-2.59		-3.36			-4.58
		(1.20)			(1.86)		(4.44)**			(3.16)**		(5.71)**			(5.69)**
ΔKURT			0.06		0.70			-0.47		0.36			-0.64		1.22
			(0.23)		(1.81)			(1.44)		(0.75)			(1.90)		(2.44)*
ΔSKEW KURT				-0.19	-0.18				-0.41	-0.16				-0.40	-0.07
				(1.36)	(1.12)				(2.05)*	(0.73)				(1.42)	(0.26)
INTERCEPT	-18.02	-33.22	-33.26	-33.61	-34.94	-19.45	-28.19	-27.33	-28.59	-29.01	-20.13	-18.30	-18.31	-18.15	-19.81
	(29.32)**	(14.03)**	(13.86)**	(14.05)**	(13.90)**	(29.01)**	(10.71)**	(10.27)**	(10.61)**	(10.16)**	(33.49)**	(7.89)**	(7.84)**	(7.67)**	(8.19)**

Figure 1: Jump premiums and changes in implied skewness and kurtosis

Figure 1 shows the effect of changing risk premiums on the percentage difference in the option price (panel A) and level difference in implied volatility (panel B) for case II, III, and IV relative to case I. Each of the lines represents a fitted value of the individual data points. The fitted line for K/S less than 1 captures option and implied volatility changes for OTM puts, for K/S greater than 1 the line captures the changes in OTM calls, for K/S equal to 1 the line captures the average change in the ATM call and put. The initial starting values use a stock price of $100, a risk-free rate of 3%, an underlying volatility of 50%, and strike prices ranging from $80 to $120 in $1 increments. The stochastic volatility parameters, κ,θ, ξ, and ρ, are set equal to 2, .25, .3 and -.5 respectively, and never change. The jump parameters λ, λ_{Π}, μ_{Π}^{*}, μ_{Π}, and σ_{Π}^{2}, are initially set equal to 1, 0, 0, 0, and .15, respectively. The risk premiums are all set equal to zero for case I. For case II, the jump size is equal to 10%. For case III the jump size is equal to -10. For case IV the jump intensity is equal to 2.

Panel A: Percentage Change in Option Price



Panel B: Level Change in Option Volatility