Implied Standard Deviations And Put-Call Parity Relations Around Primary Security Offerings

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Abstract

This study examines the response of the options market to new security registrations and issuances. Two methods are employed to gauge option market response. The first involves the calculation of implied standard deviations (ISDs) around primary security registration and issuance dates. The second employs American put-call parity to simultaneously evaluate the relationship between put, call and stock prices around these dates. We find a statistically significant mean decrease in relative ISD five trading days before announcement of new stock issuances and a statistically significant mean increase in relative ISD one day before announcement of new debt issuances. Put-call parity tests provide evidence that the options market anticipates stock price decreases prior to announcements of both stock and debt issuance.

Introduction

The impact of new security issuance on stock prices has been widely studied. Research on capital acquisition shows that the more equity-like the financing instrument, the more negative the stock price reaction tends to be¹. This study extends research in this area to the equity options market. In addition, this paper adds to the body of research into whether firm specific events are anticipated in the options market prior to the equity market.

Readers with comments or questions are encouraged to contact the authors via e-mail.

There are a number of avenues by which new security issuance may affect option prices. First, capital structure changes affect the standard deviation of future cash flows to equity investors. Because option prices are a function of the standard deviation of the continuously compounded return on the underlying stock, capital structure changes have a theoretical impact on option prices². Second, option prices are a function of the price of the underlying stock. If new security issuance impacts stock prices, this should be transmitted to option prices. Finally, any stock price adjustment associated with new security issuance should increase short-term price volatility. This should also affect option

prices.

The purpose of this study is to determine whether there are economically significant impacts in the options market resulting from new security issuance and, if so, the timing of such impacts. Two methods are employed to gauge option market response. The first involves the calculation of implied standard deviations (ISDs) around primary security registration and issuance dates. The second employs American put-call parity to simultaneously evaluate the relationship between put, call, and stock prices. Both methods use a control sample methodology to eliminate model biases and correct for market-wide effects.

Previous studies have evaluated the general relationship between the options and underlying equity markets. Stephan and Whaley (1990) show that equity option price adjustments lag price changes in the underlying stock by as much as 15 minutes, while Finucane (1991) presents evidence that index option prices lead the stock market by at least 15 minutes. Choe and Freund (1992) study both the equity and index markets using a European put-call parity methodology. They find that index option prices lead the index level, while equity option prices lag underlying stock prices. The divergent results are attributed to different trading mechanisms in the two markets.

The nature and timing of the impact that company specific events have on option prices and ISDs have also been studied. Bhattacharya (1987) examines the relative impact of dividend and earnings announcements on stock and option prices. He finds that the option market contains information beyond that in the stock market, though the incremental price impacts are not large. Patell and Wolfson (1979,1980) report that option ISDs rise in the period preceding earnings announcements, while Levy and Yoder (1993) find that target firm ISDs begin to increase three days before takeover announcements. Interestingly, the rising target ISDs are

found to occur one day before significantly positive abnormal stock returns.

The present study finds that options markets tend to lead equity markets around the announcement of pending stock and debt issuances. A significant decrease in the mean relative ISD for the stock issuance sample is detected five trading days prior to the announcement date. A significant increase in the mean relative ISD for the debt issuance sample is detected one trading day prior to the announcement date. In addition, put-call parity results are consistent with the options market leading the equity market in reflecting information contained in security issuance announcements.

Testable Hypotheses

Because security offerings have capital structure and underlying security pricing impacts, there is reason to expect that option prices will be affected by stock and bond issuances. There are two major option pricing implications of new security issuance. The first is a direct stock price effect. Stock prices have been found to react significantly to issuances of certain types of securities. In an examination of 388 seasoned equity offerings of industrial firms, Masulis and Korwar (1986) demonstrate that, on average, the issuance of seasoned equity has negative consequences for a firm's stock price. They report a statistically significant two-day return for the common stock of the issuer of -3.25 percent, versus an average market return of +0.06 percent. Judging from the valuation effect, common stock offerings seem to signal adverse information about the issuing firm, though the exact nature of that information is not well understood. Dann and Mikkelsen (1984) find that convertible debt offerings have a less severe, though still negative, impact on shareholder wealth. In contrast, the valuation impact of straight debt offerings is negligible. Examining a sample of 459 issuances, Eckbo (1986) finds a statistically insignificant announcement period abnormal stock return. Taken collectively, these

studies indicate that negative stock price impacts are directly related to the extent to which the new issue is equity.

Ceteris paribus, negative stock returns lead to decreases in call prices and increases in put prices. Thus, the predicted direct price effect for common stock offerings is negative for calls and positive for puts. Based on the findings of Eckbo (1986), straight debt offerings should not affect either call or put values through changes in the issuer's stock price. It should be noted, however, that this study finds a significantly negative mean abnormal return for the debt announcement sample on day -4.

The second hypothesized effect of security offerings is a stock return volatility effect. Leverage-increasing capital structure changes increase the variability of the firm's cash flows, and hence the variability of its market value. Hamada (1972) demonstrates this empirically, finding a positive relationship between leverage and equity beta within all nine industries he examines. Because call and put prices are both positive functions of the variability of returns on the underlying stock, leverage increasing (decreasing) capital structure changes should exert a positive (negative) impact on option prices. If debt issuance has a neutral stock price effect, then we would expect a positive impact on both put and call prices. If debt issuance has a negative stock price effect, then the impact on call prices is uncertain and the hypothesized impact

on put prices is positive.

Common stock issuances should have an unambiguously negative impact on call prices, due to an expected drop in stock prices as well as a negative volatility effect. In contrast, for puts the positive price effect is at least partially offset by a negative volatility effect. Which factor dominates for puts is an empirical question; a priori, the net impact is not readily predictable. Table 1 summarizes the option price implications of the hypotheses discussed above.

Data and Methodology

A list of options available on the Chicago Board Options Exchange (CBOE) at any time during the period January 1, 1983 through December 31, 1989 is obtained from the CBOE. Options are eliminated from the sample if the underlying common stock was not traded on the New York or American Stock Exchanges, or if the associated firm did not make any public security offerings during 1983-1989. The sample selection procedure requires that debt and stock offerings, identified by Investment Dealers' Digest, be single issues unaccompanied by any other security. Hence, all unit and dual offerings are omitted. These initial criteria produce a primary data set of 247 issuances.

The earlier of the public announcement and registration dates (henceforth simply referred to as the "announcement date") is ob-

Table 1
Observed and Hypothesized Price Reactions to Debt and Common Stock Offerings

Security Issued	Observed Price Reaction for Common Stock	Expected Price Reaction for	
		Call Option	Put Option
Straight Debt	Zero [source: Eckbo (1986)]	<i>Positive</i>	<i>Positive</i>
	Negative [source: present study]	<i>Unclear</i>	<i>Positive</i>
Common Stock	Negative [source: Masulis & Korwar (1986)]	<i>Negative</i>	<i>Unclear</i>

tained from Investment Dealers' Digest and The Wall Street Journal Index. The Wall Street Journal Index is used to confirm the issuance date and to search for contaminating events occurring five days on either side of the announcement or issuance date. This additional screen results in the deletion of 12 observations. The final sample consists of 189 straight debt offerings and 34 common stock offerings.³

Each of the 34 common stock offerings has a unique announcement date, though the 189 debt offerings are associated with only 133 announcement dates due to a preponderance of shelf registrations in the sample. With shelf registrations, issuances are often made in stages over many months.⁴ Table 2 presents a chronological distribution of security announcements and issuances. A disproportionately large number of common stock issuances come from 1983, though this is not entirely surprising in light of the dramatic runup in stock prices in the second half of 1982.⁵

Table 2
Chronological Distribution of Debt and Common Stock Offerings

Year	Common Stock	Straight Debt	
	Announcements and Issuances	Announcements	Issuances
1983	12	7	7
1984	3	11	9
1985	5	25	26
1986	4	35	42
1987	7	25	33
1988	3	18	41
1989	0	12	31
Total	34	133	189

Daily stock returns are drawn from the Center for Research in Security Prices (CRSP) tapes, and event study methodology is used to compute abnormal returns for security issuers around announcement and issuance dates. In estimating market model parameters, the CRSP equally weighted index is used as a proxy for the market portfolio. The pooled parameter estima-

tion period runs from 132 days before through 6 days before and 6 days after through 132 days after the information event. The 11-day event period spans day -5 through day +5.

Intraday, time-stamped option quote and stock price data are obtained from the Berkeley Options Data Base.⁶ The announcement and issuance are treated as two separate events. Six trading days prior to every announcement and issuance event, the nearest-the-money put and call option pair is selected for the stock. For the announcement sample, the common expiration date of the put and call must be beyond the security issuance date so that any impacts associated with the offering are captured.⁷ On the same date a control put-call option pair is assigned to the sample pair to adjust for market-wide effects. The control options must be written on a different underlying stock and have the same expiration date as the sample pair. In addition, the ratio of stock price to exercise price for the control options must be within .02 of the ratio for the

sample pair. After selecting the sample and control options, price data are collected for the period running from six trading days prior to the announcement or issuance event through five trading days after the event. To be included in the sample, the put and call option prices must be quoted within

15 minutes of each other and the associated stock price for each must be the same.

Two types of tests are conducted. The first measures the difference between the sample and control trading day percentage changes in ISDs. To calculate ISDs, call option observations obtained from the procedure described above are used in conjunction with the Black-

Scholes (1973) model with dividend correction. Dividend information is obtained from *Moody's Dividend Record* and risk-free rates are obtained from *The Wall Street Journal* using the yields from treasury bills with maturity dates closest to the option expiration dates. The test statistic for each option in the sample is defined as:

$$D(t) = \text{PCISD}(s,t) - \text{PCISD}(c,t) \quad (1)$$

where $\text{PCISD}(s,t)$ and $\text{PCISD}(c,t)$ are the percentage changes in implied standard deviations from trading day $t-1$ to day t for the sample and control call options, respectively. $D(t)$ can be interpreted as indicating relative changes in sample ISDs. The use of a control option is designed to mitigate any biases of the Black-Scholes model since both the sample and control options have the same expiration date and moneyness. The technique also controls for market wide volatility fluctuations, thereby isolating firm-specific volatility changes. The statistic above is used to determine the nature and timing of changes in expected future stock price volatility as reflected in the options market.

Since common stock offerings are empirically observed to cause declines in stock prices, and there is evidence that option prices may lead stock prices around certain information events, an interesting issue is whether option prices lead stock prices around new stock offerings. If so, then changes should be detectable in the relative prices of calls, puts, and stocks. The put-call parity theorem for American options on dividend-paying stocks is used to evaluate relative prices around stock announcements and issuances. This approach has the feature of simultaneously incorporating call, put, and stock prices in assessing the impact of security offerings.

In the case of known risk-free rates and up to 3 perfectly forecast dividends, the relationship between stock and American put and call option prices at time t is:⁸

$$C(A,t) - P(B,t) + PV(D) + K \geq S(t) \geq C(B,t) - P(A,t) + L \quad (2)$$

In the equation above, $C(\bullet,t)$, $P(\bullet,t)$, and $S(\bullet,t)$ are the call, put and stock prices at time t , respectively. The modifiers B and A indicate bid and ask prices, respectively. $PV(D)$ is the present value of the dividends forecast over the life of the options, K is the exercise price, and L is the minimum of the sum of the present values of the exercise price and dividends paid assuming exercise just prior to each ex-dividend date and the expiration date. If the options market reacts to a new stock offering prior to the stock market, then the location of the stock price within the boundaries given in equation 2 will change. Specifically, the call price would decline, the put price would rise and both the upper stock price boundary and lower stock price boundary would shift downward. If this occurs prior to a stock price decline, then the observed stock price will be located closer to, if not above, the upper boundary. A subsequent downward adjustment in the stock price would lead to a lower location of the stock price within the put-call parity boundaries. In order to detect changes in relative put, call, and stock prices, the following put-call parity metric is formed:

$$SP(t) = [S(t) - LB(t)] / [UB(t) - LB(t)] \quad (3)$$

where $LB(t)$ and $UB(t)$ are the respective lower and upper stock price boundaries given in equation 2.

Equation 3 is calculated for both the security issuance sample and the control sample. The test statistic is the change in the difference between the sample and control put-call parity values:

$$SPC(t) = (SP(s,t) - SP(c,t)) - (SP(s,t-1) - SP(c,t-1)) \quad (4)$$

where $SP(s,t)$ and $SP(c,t)$ are the put-call parity statistics for the stock announcement and control options, respectively. Positive mean values of $SPC(t)$ followed by negative mean values is consistent with the notion that the options market anticipates a subsequent decline in stock prices.

Table 3
Announcement Period Abnormal Stock Returns
for Debt and Common Stock Issuers

Event Day	Abnormal Return (%)	t	% Positive
<i>Panel A: Common Stock Registrations (n = 34)</i>			
-5	0.01	0.03	47.1
-4	-0.21	-0.63	38.2
-3	0.60	1.77**	55.9
-2	-0.46	-1.37*	35.3
-1	-0.35	-1.05	41.2
0	-0.83	-2.45***	38.2
1	-0.49	-1.45*	38.2
2	0.22	0.67	52.9
3	0.19	0.55	61.8
4	0.53	1.57*	64.7
5	-0.24	-0.70	35.3
0 & 1	-1.32	-2.76***	38.2
<i>Panel B: Straight Debt Registrations (n = 133)</i>			
-5	-0.01	-0.06	45.1
-4	-0.29	-2.27**	39.8
-3	0.18	1.38*	42.9
-2	-0.07	-0.54	42.9
-1	0.13	1.02	46.6
0	-0.12	-0.92	44.4
1	-0.06	-0.46	40.1
2	-0.15	-1.17	43.6
3	0.03	0.25	44.4
4	0.09	0.70	45.9
5	-0.13	-1.04	44.4
0 & 1	-0.17	-0.98	47.4
*** Statistically significant at the .01 level, two-tailed test.			
** Statistically significant at the .05 level, two-tailed test.			
* Statistically significant at the .10 level, two-tailed test.			

Results

Panel A of Table 3 indicates that announcements of a pending common stock offering are met with a significantly negative market response as also found by Masulis and Korwar

(1986). Unlike the results reported by Eckbo (1986) for an earlier time period, we find a significantly negative mean abnormal return for the debt announcement sample on day -4. This is followed by a smaller and less significant positive abnormal return on day -3. Issuance period abnormal returns for both security types are not statistically different from zero.

Table 4 provides the mean values of $D(t)$ over the security announcement event period, defined as five trading days before the announcement to 5 trading days after the announcement. For the stock announcement sample in panel A, a large negative mean value of $D(t)$ is detected on day -5.⁹ This is statistically significant under both a t-test and non-parametric sign ranked test, and is consistent with an early option market reflection of the leverage reduction associated with new stock issuance.¹⁰ It is also consistent with call option prices anticipating the negative stock price effects of new security issuance.

Panel B of Table 4 contains results for the debt announcement period. The mean value of $D(t)$ is positive for each of the four days leading up to the announcement date, with a relatively large and statistically significant positive value on day -1. This pattern suggests that the options market anticipates the debt issuance announcement and the attendant leverage increasing effect. Taken together, the results presented in Table 4 indicate that the options market reflects the leverage implications of new security issuance prior to the announcement of the leverage change. This is consistent with the findings of Patell and Wolfson (1979,1980) and Levy and Yoder (1993) that firm specific information is impounded in the options market prior to public announcement.

Table 5 presents results for the relative change in the put-call parity statistic around stock (Panel A) and debt (Panel B) announcements. For the stock announcement sample, there is a statistically significant positive adjust-

Table 4
Mean Difference Between Announcement Sample and Control Sample Percentage Changes
in Implied Standard Deviations

This table provides the mean values of the statistic $D(t)$ for each of the eleven days centered around the security announcement date, where $D(t) = PCISD(s,t) - PCISD(c,t)$. $PCISD(s,t)$ and $PCISD(c,t)$ are the percentage changes in implied standard deviation from day $t-1$ to day t for announcement and control sample options, respectively. Panel A contains the results for common stock announcements, while panel B contains the results for straight debt announcements.

<u>Event</u> <u>Day</u>	<u>D(t)</u>	<u>t-stat</u>	<u>prob > t </u>	<u>SR</u>	<u>prob > SR </u>
<i>Panel A: Common Stock Announcements</i>					
-5	-0.0438	-2.619	0.012	-177.0	0.037
-4	-0.0008	-0.039		-2.0	
-3	0.0125	0.570		74.0	
-2	0.0072	0.243		-11.0	
-1	-0.0037	-0.166		-14.0	
0	0.0139	0.545		27.5	
1	0.0231	1.026		66.5	
2	-0.0165	-0.642		-32.0	
3	0.0035	0.150		4.0	
4	-0.0185	-0.997		-42.5	
5	0.0226	1.329		54.5	
<i>Panel B: Straight Debt Announcements</i>					
-5	-0.0129	-0.814		148.0	
-4	0.0069	0.601		200.0	
-3	0.0084	0.559		77.0	
-2	0.0026	0.203		55.0	
-1	0.0253	2.057	0.043	288.0	0.099
0	-0.0135	-1.023		-114.5	
1	-0.0020	-0.169		-31.5	
2	-0.0158	-1.063		-189.5	
3	0.0031	0.220		-12.5	
4	0.0127	1.076		178.5	
5	0.0039	0.198		165.5	

ment observed on day -5 (p-value = 0.076). Recall that a positive value of the statistic $SPC(t)$ is consistent with the option market's anticipation of a stock price decline. The mean value of $SPC(t)$ is then negative on days 0 through 3 and

again on day 5, with the day 5 value statistically significant and the day 0 value narrowly insignificant at conventional levels (p-value = 0.109). This result is entirely consistent with the option market's leading the stock market in the

Table 5
Mean Change in the Difference Between Announcement Sample
and Control Sample Put-Call Parity Statistics

The put call parity statistic indicates the location of the observed stock price within the boundaries given by the American put-call parity relationship. The statistic is $SP(t) = (S(t) - LB(t)) / UB(t) - LB(t)$, where $S(t)$ is the observed stock price at time t , and $UB(t)$ and $LB(t)$ are the upper and lower boundaries from the American put-call parity relationship, respectively. This statistic is calculated for both the announcement and control samples. The trading day change in the difference is $SPC(t) = (SP(s,t) - SP(c,t)) - (SP(s,t-1) - SP(c,t-1))$, where $SP(s,t)$ and $SP(c,t)$ are the put-call parity statistics for the announcement and control options, respectively. Panel A contains results for common stock announcements, while panel B contains results for straight debt announcements.

Event Day	SPC(t)	t-stat	prob > t	SR	prob > SR
<i>Panel A: Common Stock Announcements</i>					
-5	0.0936	1.832	0.076	89.5	
-4	-0.0034	-0.058		25.0	
-3	-0.0384	-0.913		-53.0	
-2	0.0422	0.847		50.0	
-1	0.0269	0.421		12.0	
0	-0.0776	-1.664		-56.5	
1	-0.0591	-1.049		-39.5	
2	-0.0313	-0.643		-19.5	
3	-0.0065	-0.108		-15.5	
4	0.0476	0.765		30.5	
5	-0.1181	-1.730	0.097	-64.5	0.082
<i>Panel B: Straight Debt Announcements</i>					
-5	0.0793	2.209	0.031	256.5	0.040
-4	-0.0516	-1.353		-125.0	
-3	0.0424	1.096		60.0	
-2	-0.0296	-0.890		-22.0	
-1	0.0047	0.159		22.5	
0	-0.0197	-0.749		-38.0	
1	0.0101	0.315		59.0	
2	0.0308	0.793		9.0	
3	-0.0004	-0.007		18.0	
4	-0.0120	-0.239		-46.0	
5	0.0417	0.647		-38.0	

period preceding the stock announcement. Once the stock price reflects the negative information conveyed by the announcement, it moves to a lower position within the put-call parity boundaries (which already reflect this information).

Put-call parity results for the debt announcement sample are also consistent with the

options market leading the stock market. We detect a positive and significant mean value of $SPC(t)$ on day -5 which suggests that put and call prices anticipate the negative stock price reaction on day -4 as reported in Table 3.

Table 6 provides the results for the behavior of relative percentage changes in ISDs

Table 6
Mean Difference Between Issuance Sample and Control Sample Percentage Changes
in Implied Standard Deviations

This table provides the mean values of the statistic $D(t)$ for each of the eleven days centered around the security issuance date, where $D(t) = PCISD(s,t) - PCISD(c,t)$. $PCISD(s,t)$ and $PCISD(c,t)$ are the percentage changes in implied standard deviation from day $t-1$ to day t for issuance and control sample options, respectively. Panel A contains the results for common stock issuances, while panel B contains the results for straight debt issuances.

Event Day	D(t)	t-stat	prob > t	SR	prob > SR
<i>Panel A: Common Stock Issuance</i>					
-5	-0.0032	-0.167		-13.0	
-4	0.0092	0.534		16.0	
-3	-0.0080	-0.291		16.5	
-2	-0.0467	-1.576		-94.5	
-1	0.0209	1.189		43.5	
0	-0.0318	-1.706	0.097	-111.5	0.093
1	-0.0135	-0.559		-39.5	
2	0.0195	0.759		41.0	
3	-0.0322	-1.897	0.068	-86.5	0.075
4	-0.0003	-0.016		-8.5	
5	-0.0236	-0.937		-7.0	
<i>Panel B: Straight Debt Issuance</i>					
-5	-0.0040	-0.426		-410.0	
-4	-0.0055	-0.581		-139.0	
-3	0.0102	1.013		338.0	
-2	-0.0213	-1.550		-608.5	
-1	-0.0074	-0.575		-230.0	
0	-0.0086	-0.920		-510.5	
1	-0.0101	-0.887		-206.5	
2	-0.0023	-0.208		-216.5	
3	0.0004	0.031		61.0	
4	0.0052	0.417		223.5	
5	-0.0086	-0.546		72.0	

around security issuance dates. The results for stock issuance in panel A indicate statistically significant percentage decreases in the relative ISD on day 0 (p-value = 0.097) and day +3 (p-value = 0.068). Given that the intention to en-

act a leverage reducing capital structure change has already been revealed, it may be somewhat surprising to observe this degree of reaction in the option market. However, issue dates are frequently not known in advance and since the

option pricing model implied variance is a time weighted average of the variance expected to occur over the life of the option, an issuance event can be significant to the options market. In contrast to the stock issuance results, panel B of Table 6 indicates no significant reaction of relative ISDs around debt issuance dates. This result can be explained only to the extent that debt issuance dates are more predictable than stock issuance dates. However, at this point there is little evidence available to support such a conjecture.

Conclusions

This study employs two different tests to evaluate the options market impact of new security offerings. In both, we use a control sample of options to adjust for market wide effects. The results provide support for advance reaction in the options market to new stock announcements. A statistically significant mean relative decrease in the ISD for call options written on the stock of firms announcing new stock offerings is observed on event day -5. The study also finds that on day -5, relative put and call prices reflect an expected decline in the stock price of firms announcing a new stock offering. Statistically significant declines in the mean relative ISD are also observed on event days 0 and +3 relative to stock issuance dates. This finding may reflect the resolution of uncertainty regarding the date of the actual leverage change.

We find that the options market anticipates leverage *increasing* capital structure changes as well. There is a relative increase in the debt announcement sample mean relative ISD for each of the four days leading up to the announcement date, with the increase statistically significant on day -1. Put-call parity tests also support the notion that the options market leads the equity market around debt issuance announcements. The negative stock price reaction on day -4 is anticipated in the options market on the preceding trading day.

The results of this study are consistent with those of other studies that find that volatility and price effects of firm specific events are reflected in the options market in advance of the stock market.

Directions for Future Research

Numerous events impact the volatility of a firm's future cash flows. The options market provides an efficient means for evaluating the expected volatility impact of firm specific events. Mergers and acquisitions may increase or decrease future cash flow volatility, depending on stand-alone volatilities and correlations. A logical further application of the methodology we present here is to evaluate the extent to which the options market correctly distinguishes between volatility increasing and decreasing combinations. In the same vein, capital budgeting decisions may impact the standard deviation of a firm's future cash flow both positively and negatively. An interesting application of the methodology would be to determine whether the options market is able to assess *ex ante* the impact that major new projects will have on the volatility of a firm's cash flows.

Other corporate events that would lend themselves to this type of analysis would include dividend declarations and stock buy-backs. The general procedures employed here could also be applied to macroeconomic events such as changes in discount rates. This latter application would be interesting because the risk free rate is a parameter directly affecting option prices. □

Footnotes

1. The stock market reaction to securities offerings is considered extensively in Volume 15 of the *Journal of Financial Economics*. Wealth effects for pre-existing bondholders around stock issuances are reported by Kalay and Shimrat (1987).
2. Geske (1979) provides a theoretical framework for the impact of capital

- structure changes on call option prices.
3. The sample selection procedure results in identification of 12 convertible debt offerings, though the sample size was deemed to be too small to allow meaningful analysis.
4. For the debt issuance sample, we include only the first offering.
5. Marsh (1982) finds that equity market conditions are a major determinant of a firm's decision to use common stock financing.
6. Quotes occurring prior to 10 A.M. were omitted to avoid unusual price behavior resulting from overnight information.
7. Option model implied variances could be interpreted as the average variance per unit of time from the valuation date to the option expiration date (see Patell and Wolfson (1979, 1981)). Since this study evaluates the impact of leverage changes on option ISDs, the sample is restricted to options whose remaining life spans the leverage change.
8. For a proof of this no arbitrage relation, see Jarrow and Rudd (1983, pp. 69-79). The following methodology is similar to that employed by Figlewski and Webb (1993, fn. 12), Finucane (1991) and Broughton and Chance (1993).
9. The event windows for this test and the following put-call parity test were extended back to day -10 and forward to day +10. There were no statistically significant mean values of D_t or S_t prior to day -5 or after day +5.
10. We observe relatively large and positive, but statistically insignificant, mean values of D_t on days +1 and +5. This apparent 'rebound' effect is believed to reflect the short-term volatility impact associated with the stock price adjustment to the equity issuance announcement.

References

1. Bhattacharya, Mihir. "Price Changes of Related Securities: The Case of Call Options and Stock." *Journal of Financial and Quantitative Analysis* 22(March 1987), pp. 1-15.
2. Billingsley, Randall S., Robert E. Lamy and G. Rodney Thompson. "Valuation of Primary Issue Convertible Bonds." *Journal of Financial Research* 10 (Fall 1986), pp. 251-259.
3. Black, Fisher and Myron S. Scholes. "The Pricing of Options and Corporate Liabilities." *Journal of Political Economy* 81(May-June 1973), pp. 637-659.
4. Broughton, John B. and Don M. Chance. "The Value Line Enigma Extended: An Examination of the Performance of Option Recommendations." *Journal of Business* 66(October 1993), pp. 541-569.
5. Choe, Hyuk and Steven Freund. "Intraday Relations Between Actual Stock Prices and Stock Prices Implied by Put-Call Parity." Pennsylvania State University Working Paper (October 1992).
6. Dann, Larry Y. and Wayne H. Mikkelson. "Convertible Debt Issuance, Capital Structure Change and Financing-Related Information: Some New Evidence." *Journal of Financial Economics*, 13(1984), pp. 157-186.
7. Figlewski, Stephen and Gwendolyn P. Webb. "Options, Short Sales, and Market Completeness" *Journal of Finance*, 48 (June 1993), pp. 761-777.
8. Finucane, Thomas J. "Put-Call Parity and Expected Returns." *Journal of Financial and Quantitative Analysis*, 26(December 1991), pp. 445-457.
9. Geske, Robert. "The Valuation of Compound Options." *Journal of Financial Economics*, 1(1979), pp. 63-82.
10. Hamada, Robert S. "The Effect of the Firm's Capital Structure on the Systematic Risk of Common Stocks." *Journal of Finance*, 27(May 1972), pp. 435-452.
11. Jarrow, Robert A. and Andrew Rudd. *Option Pricing*, 1983, Homewood: Richard D. Irwin.

12. Kalay, Avner and Adam Shimrat. "Firm Value and Seasoned Equity Issues: Price Pressure, Wealth Redistribution, or Negative Information?" *Journal of Financial Economics* 19(September 1987), pp. 109-126.
13. King, Raymond D. "The Effect of Convertible Bond Equity Values on Dilution and Leverage." *Accounting Review* 59 (July 1984), pp. 419-431.
14. Levy, Haim and James Yoder. "The Behavior of Option Implied Standard Deviations Around Merger and Acquisition Announcements." *Financial Review* 28(May 1993), pp. 261-272.
15. Marsh, Paul. "The Choice Between Equity and Debt: An Empirical Study." *Journal of Finance*, 37(March 1982), pp. 121-144.
16. Masulis, Ronald W. and Ashok N. Korwar. "Seasoned Equity Offerings: An Empirical Investigation." *Journal of Financial Economics* 15(1986), pp. 91-118.
17. Patell, James M. and Mark A. Wolfson. "Anticipated Information Releases Reflected in Call Option Prices." *Journal of Accounting and Economics*, 1(Autumn 1979), pp. 117-140.
18. Patell, James M. and Mark A. Wolfson. "The Ex Ante and Ex Post Price Effects of Quarterly Earnings Announcements Reflected in Option and Stock Prices." *Journal of Accounting Research*, 19(Autumn 1981), pp. 434-458.
19. Stephan, Jens A., and Robert E. Whaley. "Intraday Price Changes and Trading Volume Relations in the Stock and Stock Options Markets." *Journal of Finance*, 45(March 1990), pp. 191-220.