THREE ESSAYS ON THE EFFECTS OF
EQUITY OPTION INTRODUCTION

DISSERTATION

Presented to the Graduate Council of the
University of North Texas in Partial
Fulfillment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

By

William F. Ragle, B.S., M.B.A
Denton, Texas
August 1996
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This dissertation is structured as three essays on various aspects of equity option introduction. Topics addressed include the relative predictability of introduction, the relationship between predictability of introduction and the price effect associated with introduction, and a comparison of the price response of optioned versus nonoptioned stocks to changes in dividends.

Essay 1 involves use of firm-specific variables in a LOGIT model to allow assignment of a probability of equity option introduction. Two samples were developed: one of firms that were optioned, the other of firms which met the objective standards but were not optioned. A LOGIT model is used to assign a probability of optioning to each firm. A holdout sample is used to test the out-of-sample predictive power of the model. Firms were correctly classified as optioned or nonoptioned in about 85 percent of cases.

Various researchers have detected abnormal positive returns associated with stock option introduction. In an efficient market context, this would indicate that option introduction is "good" news to financial markets. If optioning is predictable, stocks with a higher probability
of optioning would be expected to show less price response when options are introduced. In Essay 2, the relationship between the probability of optioning and abnormal returns is tested using a standard event methodology. Utilizing nonparametric statistics, no significant differences were detected among abnormal returns of portfolios formed on the basis of probability of option introduction.

Essay 3 compares abnormal returns of optioned and nonoptioned stocks around announced dividend changes. Two samples were obtained. Firms in the first (second) sample had significant dividend changes while options were (were not) available on their stocks. Standard event methodology is used to compare price responses of the two samples. If the price response of optioned stocks is less pronounced than the price response of nonoptioned stocks, this may indicate that optioned stocks are more efficiently priced. Reasons for this increased efficiency are examined in the study. Abnormal returns for the optioned sample were not significantly different from zero. Those for the nonoptioned sample were significantly different from zero for all event windows tested.
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INTRODUCTION

On April 26, 1973 the Chicago Board Options Exchange (CBOE) became the first registered exchange for trading listed call options. The CBOE provided a central location where options could be traded efficiently. Option contracts were standardized, commission costs were reduced, and liquidity was enhanced by the presence of an active secondary market. Due to benefits derived from existence of the CBOE, trading in options grew at a tremendous rate in the years following 1973. By 1983, trading volume on the CBOE rivaled volume on the New York Stock Exchange.

In 1973, Black and Scholes derived a closed-end formula for pricing call options. Underlying the Black-Scholes pricing model is the assumption that certain characteristics of stock price behavior affect option prices in a systematic way. It has been generally accepted that this relationship between stock prices and option prices is uni-directional. That is, option prices and option market behavior have little effect on markets for the underlying stock.

Researchers have begun to question this unilateral relationship between stocks and options. Recent research suggests that trading volume in the options markets may be useful in predicting stock price changes. Evidence
regarding whether the stock market or the options market reflects new information earlier is inconclusive.

The goal in this dissertation is to test certain market efficiency aspects of equity option introduction. The thesis is organized as three essays.

The first essay represents an attempt to determine whether introduction of equity options was predictable over the period from October 1991 through December 1993. The hypothesis regarding predictability was tested by developing a LOGIT model. Firm-specific variables representing trading volume, market value of equity, stock price variance, and cites in the Wall Street Journal were used as independent variables. Output of the model allowed assignment of a probability of optioning to each stock that met required objective criteria. Firms in the test sample were correctly classified by the model in 85 percent of cases. Firms in a holdout sample were correctly classified in 87 percent of cases.

Having developed the model, we then want to examine market efficiency implications of predictability of optioning. This issue is addressed in the second essay.

Several empirical analyses have indicated that option introduction is accompanied by positive abnormal returns. If stock markets are efficient, stocks with a lower probability of option introduction would be expected to have a greater price response than would stocks with a higher
probability of option introduction. This comparison is made in the second essay.

The full sample for the second essay includes all stocks from essay one that had equity options introduced over the test period. Firms with contaminating events during the event period were removed from the sample. The sample was partitioned based on predicted probability of option introduction. Event study results were then obtained on portfolios of stocks with highest, lowest, and intermediate probability of optioning. Using a median test and a Kruskal-Wallis test, there were no significant differences among abnormal returns for the three portfolios.

Essay two also involved regression analysis. The goal was to determine whether the probability of optioning was related to abnormal returns around the date of optioning. Two portfolios were formed based on predicted probability of option introduction. Optioned (nonoptioned) stocks were assigned a dummy variable of 1 (0). Abnormal returns were used as the dependent variable. Neither the dummy variable nor the probability of optioning was a significant explanatory variable in the regression analysis.

Essay three tests information asymmetry between optioned and nonoptioned stocks. Recent theoretical and empirical research indicate that information asymmetry is mitigated when equity options are available on a stock. This may be caused by informed traders trading in the
options market, thus communicating insider information regarding future cash flows.

Dividend changes are used as a proxy for insider information. It has been shown that dividend changes produce a stock price response of the same sign as the dividend change. In this essay, this price response is compared using portfolios of optioned and nonoptioned stocks. If optioned stocks are priced more efficiently, one would expect the price response to be less marked for optioned stocks than for nonoptioned stocks. Using a Z* statistic, abnormal returns for the portfolio of nonoptioned stocks were significantly greater than those for the portfolio of optioned stocks.
ESSAY I

PREDICTABILITY OF STOCK OPTION INTRODUCTION

INTRODUCTION TO THE STUDY

Researchers have detected abnormal positive returns associated with introduction of equity options. This phenomenon indicates that investors associate options trading with an increasing stock price. For this to be the case in an efficient market, introduction of equity options must convey some "good news" to the market that was not available prior to option introduction.

Assuming that the "good news" is the initiation of options trading, efficient markets theory would indicate that option introduction was not predictable before announcement by an options exchange. Had option introduction been foreseeable, the price of the underlying security would have adjusted appropriately prior to optioning.

No previous research has been directed toward determining the probability that a stock will be optioned. Given potential effects on shareholder wealth and market efficiency implications, it is important to assess that probability.
The decision whether a firm's stock will be optioned is made by staff and floor traders at the options exchanges. The firm that issued the stock does not participate in the decision. A firm must meet several objective criteria for its stock to be eligible for optioning. The firm must have at least seven million common shares outstanding and have two thousand or more benefiting shareholders. The stock must have traded at $7.50 or more on the majority of trading days in the three months prior to optioning. The stock also must be traded on either the New York Stock Exchange (NYSE), the American Stock Exchange (AMEX) or the NASDAQ.

The committee of staff and floor traders decides which of the stocks that meet these criteria will be optioned. Subjective considerations in this decision include factors such as volatility, liquidity, and name recognition.

This combination of objective and subjective measures lends itself well to statistical evaluation of the probability of a particular stock being optioned. This essay involves development of a statistical model that will allow assignment of such a probability to any stock that meets the objective criteria.

Development of the model involved identifying variables to serve as proxies for the subjective considerations mentioned above. The model was then used to determine the probability that an eligible stock will be optioned. The predictive ability of the model was then determined for both
the test sample and a holdout sample. Variables for the optioned and nonoptioned samples were compared using appropriate statistical techniques.

LITERATURE REVIEW

Probability of Occurrence of an Event:

Little work has been done testing the relationship between the relative predictability of an event and the price effect following occurrence of the event. Smith (1986) reviewed extant research regarding valuation effects of capital acquisition decisions. He consolidated his findings into five potential explanations for the observed differences in common stock price response to the financing decision. One of these explanations is the unanticipated component of an announcement or event. He notes that the more predictable an event, the smaller the associated price change should be.

Schadler and Moore (1992) modeled the probability that a firm will issue debt (equity) given that the firm will obtain external financing. Using multiple discriminant analysis, they developed a model that correctly predicted whether external financing would be obtained through debt or equity offering in 78% of the test sample cases. Using event study methodology, they then determined that, when the probability of stock issue was high, the market appeared to price that probability prior to announcement of the issue. That is, the stock of the firm with a higher probability of
stock issue had less price response to issuance of stock than did that of firms with a lower probability of stock issue.

Probability Estimation Using the LOGIT Model:

Estimation with the LOGIT model is used extensively in the finance literature. Whenever a binomial dependent variable is employed, econometric considerations outlined in the methodology section render parameter estimates obtained through use of a linear probability model inefficient. One of the most widely used methods of correcting for this condition is LOGIT analysis.

Laitinen (1994) used LOGIT analysis to predict bankruptcy based on cash flow considerations. Loh (1994) tested the influence of outside directors on the adoption of poison pills. LOGIT regression was used to predict the probability of a firm having an outside director who was also a member of the top management of another company that adopted the poison pill defense.

Wolfe, Cooperman, and Ferris (1994) investigated the probability that prestigious underwriters will underwrite a particular initial public offering (IPO). A LOGIT model was estimated to evaluate the effect of offering characteristics and prevailing market conditions on that probability. As in the current study, a holdout sample was used to test the validity of the estimated model.
Nam and Branch (1994) attempted to develop a model to determine whether an upcoming market period will be bullish or bearish. LOGIT analysis was employed to determine which data items would significantly affect the probability that a period will be bullish (bearish).

MOTIVATION FOR THE STUDY

Prior research has shown that option introduction has a favorable price response on the underlying security [(Conrad, 1989), (Kim and Young, 1991), (Haddad and Voorhies, 1991)]. The price response seems to be associated with option introduction rather than with announcement of option listing. The typical lag between announcement and listing is about five days (Conrad, 1989).

Association of price response with occurrence of an event rather than with announcement of a pending event is somewhat unusual in financial markets. Other events, such as dividend announcements and changes in capital structure, typically produce a price response upon announcement rather than upon culmination of the event in question.

There have been attempts to explain this deviation using finance theory. The prevalent conclusion is that the price response is a reflection of increased demand for the underlying stock. This demand may result from floor traders and brokers building up their inventory of stock to allow for hedging of call options on the stock (Conrad, 1989).
Rao and Ma (1987) contend that the availability of options attracts new investors as a result of the expanded risk-return opportunities of the underlying stocks. Harris and Gurel (1986) tested whether an increase in demand for the underlying stock would account for an increase in stock price. They examined shifts in demand associated with changes in the S&P 500 list. They found that these changes led to a large increase in volume, accompanied by a statistically significant increase in stock price.

The question of informational efficiency has also been dealt with in the literature. Diamond and Verrecchia (1987) determined that option introduction increases the speed of price adjustment to new information. Fedenia and Grammatikos (1992) and Rao, Tripathy and Dukes (1991) found that the bid-ask spread (BAS) decreases significantly following initiation of option trading. A decrease in the BAS is normally assumed to be indicative of an increase in informational efficiency. Jennings and Starks (1986) determined that prices of optioned stocks responded more quickly to the surprise component of earnings announcements than did prices of nonoptioned stocks. Each of these findings is consistent with an increase in informational efficiency.

We see therefore that extant empirical research reveals a statistically significant price increase related to option introduction. We see also that option trading may increase
market efficiency. However, there has been no attempt to determine whether option listing is predictable. The purpose of this essay is to address that issue.

As noted earlier, Schadler and Moore (1992) modeled the probability of a firm issuing debt or equity, given that external financing will be obtained. They then demonstrated that firms with a high probability of issuing equity had less price response to equity issuance than did firms with a low probability. It is in a spirit similar to that of Schadler and Moore that this effort is made to determine the probability of a stock being optioned.

As noted in the introduction, the decision to option a stock is made by a committee at the options exchange. The committee is composed of employees of the exchange and floor traders. The firm that issued the stock being optioned has no input into the decision whether to option. This removes any possibility of using options listing as a signaling tool.

There are certain objective criteria firms must meet to be eligible for optioning. These were listed in the introduction. Subjective considerations in the optioning decision include factors such as volatility, liquidity, name recognition, and institutional holding.

The problem addressed in this essay is development of a statistical model to predict optioning of stocks. This question requires investigation due to issues raised
earlier. No previous research has examined the probability of option introduction. It has been shown that option introduction has a positive price effect on the underlying security. It has also been shown that option introduction may increase informational efficiency of capital markets. These results cause the question of predictability to be particularly interesting and important.

HYPOTHESIS

The research question addressed in this essay is whether, and with what degree of accuracy, introduction of equity options can be predicted. The work is limited to a particular time period, based on a change in the objective criteria required by the CBOE for a stock to be eligible for optioning. The null and alternative hypotheses may be stated as:

$H_0$: Introduction of equity options is not predictable during the time period under consideration.

$H_A$: For the time period under consideration, certain firm-specific variables can be used to predict whether a particular stock will have equity options introduced.

To test the hypothesis, a statistical model was developed to assess the probability of an eligible stock being optioned. The model consists of firm-specific variables that should be considered when determining which
stocks to option. These variables serve as surrogates for the subjective variables mentioned earlier which were volatility, liquidity, name recognition, and institutional holding.

DATA

The following variables were considered as possible surrogates for subjective considerations in the decision to option. Possible surrogates for volatility of the stock price included variance of daily stock returns over the twelve months prior to a stock being optioned and variance of stock returns in the month before option introduction. Return data for this calculation were obtained from the Center for Research in Security Prices (CRSP) data bases. Variance of returns was calculated as the expectation of the squared differences from the mean return:

$$\text{VAR}(X) = E[(X - E(X))^2]$$  \hspace{1cm} (1)

The natural logarithm of the market value of equity was used as a proxy for liquidity. This is based on the assumption that market value is positively correlated with trading volume. Use of the log transformation of the market value of equity is common in finance research (e.g., Fama and French, 1992). Market value of equity was calculated by multiplying number of common shares outstanding times price
per share. This information was obtained from the Compustat database.

The number of times a firm is cited in the Wall Street Journal was used as a proxy for name recognition. This is in keeping with Conrad (1989). The underlying assumption here is that firms that have been frequently mentioned in the business press are more on the minds of investors. This may lead to increased investor interest in stock options. The Wall Street Journal Index was accessed to obtain citation information available on CD-ROM.

Trading volume in a firm's stock during the month before optioning was also used to gauge investor awareness of and interest in a particular firm. This is stated as a percentage of outstanding common shares. Data for this calculation were obtained from Compustat.

Another characteristic considered is the amount of institutional holding in a particular stock. The assumption underlying use of this variable is that institutions would be more interested in using options in hedging strategies than would individual investors. Public interest in and demand for stock options would therefore be expected to vary directly with the amount of institutional holdings. Information related to institutional holding was obtained from Standard and Poor's Security Owner's Stock Guide and is stated as a percentage of outstanding common shares.
SAMPLE

A list of all options on common stocks ever listed on all major exchanges was obtained from the Chicago Board Options Exchange (CBOE). The optioned sample used to develop the model includes stocks for which equity options were introduced between October 21, 1991 and December 31, 1993. The nonoptioned sample includes stocks that were eligible to be optioned over the same period but were not optioned at any time prior to July 31, 1994 (see rationale for this date below). In October 1991, objective standards a firm must meet to be eligible for optioning by the CBOE were lowered. Dates for inclusion in the sample were chosen based on the date of that change.

The sample of optioned firms was obtained in the following manner: there were a total of 547 firms with traded equity options introduced between October 21, 1991 and December 31, 1993. Of those, 241 firms were dropped from the sample because they lacked sufficient data on the CRSP tapes for computation of price variance. Another 26 firms were eliminated because they lacked information on Compustat needed to calculate the percentage of shares traded or the market value of equity. The final sample of optioned firms resulting from these screens was 280.

The sample of nonoptioned firms was obtained in a similar manner. The sample was first screened using Compustat data to determine which firms met the objective
criteria required for optioning; i.e., number of shares, number of shareholders, price, and trading of the stock on a major exchange. Of the stocks that passed this initial screen, all firms that were optioned any time before July 31, 1994 were omitted from the sample. Firms optioned before the test period (i.e., before October 1991) were obviously not eligible for inclusion in the nonoptioned sample. Firms optioned after the test period were assumed to be biased in favor of optioning, and were therefore eliminated from the sample.

Application of these screens resulted in a sample of 697 firms that met the objective criteria but were never optioned prior to July 31, 1994. This sample was then screened for availability of return data on CRSP and for information on shares traded and market value of equity on Compustat. Application of these screens led to a final sample size of 412 nonoptioned stocks.

Measurement of subjective variables used in the model was accomplished in the following manner. For the optioned sample, percentage of shares traded was determined in the month prior to optioning. For the nonoptioned sample, the average monthly percentage of shares traded over the entire test period was calculated.

Market value of equity was determined in the month prior to optioning for the optioned sample. The average
A LOGIT model was developed based on the variables mentioned above. The LOGISTIC function in SAS was used for this procedure. Use of LOGIT allowed assignment of a discrete probability of being optioned to each stock in the sample.

Frequently in this type of analysis, when the dependent variable is continuous, simple linear regression is used. However, when the distribution of the dependent variable is binomial, use of a linear regression model is econometrically untenable (Judge, et.al., 1988).

For example, suppose the choice variable is represented by \( y \) that takes the value 1 for optioned stocks and 0 for nonoptioned. If we observe a sample of \( T \) choices and wish to explain them using a linear regression model, we might write

\[
y_i = x_i' \beta + e_i \quad i=1,\ldots,T.
\]

(2)

Difficulties with this specification are immediate as we examine the properties the error terms must have if we wish to assume, as usual, that \( E[y_i] = x_i' \beta \). First, given the Bernoulli character of the random variable \( y_i \), it must be the case that \( E[y_i] = Pr[y_i = 1] = x_i' \beta \). Unfortunately, given that \( x_i' \beta \) is unbounded, we face the problem that this model can give probabilities outside the unit interval. Second, since \( y_i \) can only take two values, then \( e_i \) can only
take two values and these with specified probabilities if $E[y_i] = x_i'\beta$, namely

$$e_i = 1 - x_i'\beta \text{ with probability } x_i'\beta \text{ (when } y_i = 1) \quad (3)$$

and

$$e_i = -x_i'\beta \text{ with probability } 1 - x_i'\beta \text{ (when } y_i = 0) \quad (4)$$

Third, with this probability structure, $e_i$ is heteroschastic since $\text{var}(e_i) = E[y_i](1-E[y_i])$.

Greene (1990) also notes that use of a linear probability model with a binomial dependent variable produces both nonsense probabilities (less than 0 and greater than 1) and negative variances. The LOGIT model is widely used to compensate for these shortcomings of the linear model.

Use of the LOGIT model assumes that

$$Pr(\text{option}) = F(x\beta) = \frac{e^{x\beta}}{1 + e^{x\beta}} \quad (5)$$

where

$Pr(\text{option}) = \text{The probability that a stock will be optioned}$,

$x = \text{Vector of independent variables that may affect the probability of a stock being optioned}$, and

$\beta = \text{Parameter vector}$. 
The distribution of F is known as the logistic distribution. Parameters of the model are estimated using the maximum likelihood estimation method (MLE). The likelihood function is formed as

\[
L = \prod_i \frac{e^{x_i\beta}}{1 + e^{x_i\beta}} \prod_j \frac{1}{1 + e^{x_j\beta}}
\]

where \(i\) refers to stocks that were optioned and \(j\) refers to stocks that were not optioned. Maximizing this likelihood with respect to the vector \(\beta\) produces the MLE of \(\beta\).

Parameter estimates from the LOGIT model were used to calculate a \(p\) value for each stock as

\[
p = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \ldots + \beta_n X_n
\]

That \(p\) value was used to compute the probability of optioning according to the formula

\[
Prob \ of \ optioning = \frac{e^p}{1 + e^p}
\]

Comparison of Independent Variables:

Variables used in the model were compared to determine whether there is a significant difference between the variables for the optioned and nonoptioned samples. Tests used for this comparison include a two-sample t-test, a
median test, the Mann-Whitney test, and the Kolmogorov-Smirnov two-sample test.

The two-sample t-test provides a test statistic that indicates whether a difference between means as large or larger than the one observed would occur if the two population means are equal. The test statistic is calculated as

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}}$$  \hspace{1cm} (9)$$

where $\bar{X}_i$ is the sample mean of group $i$, $S_i^2$ is the variance, and $N_i$ is the sample size.

The test statistic used in the median test is

$$T = \sum_{i=1}^{c} \frac{(O_{1i} - O_{2i})^2}{n_i}$$  \hspace{1cm} (10)$$

where

$O_{1i}$ = observations from population $i$ classified as class 1,
$O_{2i}$ = observations from population $i$ classified as class 2,
$c$ = the number of populations, and
$n_i$ = the number of observations in population $i$.

The median test is used to test whether samples come from populations having the same median. The critical region of approximate size $\alpha$ corresponds to values of $T$ greater than $x_{1-\alpha}$, the $(1-\alpha)$ quantile of a chi-square random
variable with c−1 degrees of freedom. If T exceeds x_{1-\alpha}, reject the hypothesis that all populations have the same median.

The Mann-Whitney test is designed to determine whether the distribution functions of two samples are equal. Data from both samples are combined into a single ordered sample and ranks are assigned to sample values from smallest to largest. The sum of the ranks assigned to the sample from population 1 can be used to form the test statistic

\[ T = \sum_{i=1}^{n} R(X_i) \]  

(11)

where \( R(X_i) \) denotes the rank assigned to \( X_i \) for all \( i \) and \( n \) is the sample size from population 1. Reject the null hypothesis of equal distribution functions at the level of significance \( \alpha \) if \( T \) is less than the \( \alpha/2 \) quantile \( w_{\alpha/2} \) or if \( T \) is greater than the \( 1 - \alpha/2 \) quantile \( w_{1-\alpha/2} \).

The Kolmogorov-Smirnov two-sample test is also designed to determine whether the distribution functions of two samples are equal. To form the test statistic, let \( S_1(x) \) be the empirical distribution function based on the random sample \( X_1, X_2, \ldots, X_n \) and let \( S_2(x) \) be the empirical distribution function based on the other random sample \( Y_1, Y_2, \ldots, Y_m \). The test statistic \( T_1 \) is then defined as the greatest vertical distance between the two empirical distribution functions:
The null hypothesis of identical distribution functions is rejected at the level of significance $\alpha$ if the test statistic exceeds its $1 - \alpha$ quantile.

RESULTS

The LOGIT Model:

All variables noted in the data section of this paper were used in a LOGIT regression. These include variance of stock returns, the natural log of the market value of equity, the number of citations in the Wall Street Journal, trading volume in the stock, and the amount of institutional holding in the stock. Backward stepwise elimination was used to remove variables whose parameter estimates were statistically insignificant. Although use of the backward stepwise procedure in a LOGIT regression tends to bias parameter estimates on the remaining variables, it does give an indication of the significance of those variables.

Variables removed in the backward stepwise procedure were the percentage of outstanding common shares held by institutions, the daily price variance of the optioned stocks in the month prior to optioning, and the number of citations in the Wall Street Journal.
Variables remaining in the model following the backward stepwise procedure include percentage of outstanding shares traded, the natural log of the market value of equity, and daily price variance in the year prior to option introduction. Parameter estimates resulting from the LOGIT regression are found in Table 1 following chapter V.

Parameter estimates for each of the variables remaining in the model following backward stepwise elimination were highly significant. Each was significant at the 1 percent level.

The sign on each of the parameter estimates is consistent with the hypothesis under investigation. The positive sign on the percent of outstanding shares traded indicates that optioned stocks were being traded more actively than nonoptioned stocks around the time of option introduction. The parameter estimate for variance of the stock price also had a positive sign. This is consistent with the idea that stocks that are optioned are more volatile than stocks that are not optioned. The parameter estimate on the natural logarithm of the market value of equity had a positive sign. This result indicates that larger firms have a greater likelihood of being optioned.

Parameter estimates remaining following the backward stepwise elimination were used to assign each stock in both the test sample and the holdout sample a probability of being optioned. Table 2 is arranged to demonstrate the
following for both samples: the percent of optioned stocks which were correctly classified by the model as being optioned (sensitivity); the percent of nonoptioned stocks correctly classified as being nonoptioned (specificity); the percent of optioned stocks incorrectly classified as being nonoptioned (false positive rate); the percent of nonoptioned stocks incorrectly classified as being optioned (false negative rate); the overall percent of optioned and nonoptioned stocks correctly classified by the model (percent correct).

The LOGIT model was quite useful in predicting which of the stocks in the sample would be optioned over the test period. For the test (holdout) sample, use of the model led to correctly classifying a stock as optioned or nonoptioned in 85% (87.2%) of cases. Stocks were correctly classified as optioned in 77.3% (78.3%) of cases. Stocks were correctly classified as nonoptioned in 90.3% (93.2%) of cases. Stocks were incorrectly classified as optioned in only 15.5% (10.9%) of cases and were incorrectly classified as nonoptioned in 14.7% (13.9%) of cases.

Comparison of Independent Variables:

Table 3 shows results of comparison of independent variables between optioned and nonoptioned samples. Both the test and holdout samples were used for these comparisons.
Means of the samples were compared using a two-sample t-test. The mean of the optioned sample is significantly greater than the mean of the nonoptioned sample for the percent of shares traded and for the variance of the stock price. Means of the two samples for the natural log of the market value of equity are not significantly different from one another.

The median test was used to compare medians of the samples. Medians for the natural log of the market value of equity are not significantly different between the two samples. The median for the optioned sample is significantly greater than that for the nonoptioned sample for the percent of shares traded and the variance of the stock price.

Two test statistics were used to compare distribution functions of the independent variables. Mann-Whitney test results indicate that distribution functions for the natural log of the market value of equity do not differ significantly. Distribution functions for the other independent variables differ significantly.

Results of the Kolmogorov-Smirnov two-sample test present a slightly different result. Using the greatest vertical distance between the two empirical distribution functions, results indicate that the distribution functions for each of the independent variables differ significantly from one another.
INTERPRETATION

The LOGIT Model:

Results of the LOGIT regression are supportive of the alternative hypothesis under consideration. Findings indicate that, for the time period in question, it is possible to use firm-specific variables to predict with a high degree of accuracy which stocks will be optioned. For both the test sample and the holdout sample, the model correctly classified stocks as optioned or nonoptioned in more than 85 percent of cases examined.

One interesting result of the LOGIT regression was the finding that the parameter estimate for the number of citations in the Wall Street Journal was insignificant. Previous researchers, notably Conrad (1989), have found optioned stocks to have a significantly greater number of citations than nonoptioned stocks.

Comparison of Independent Variables:

Comparison of independent variables supports rejection of the null hypothesis considered in this study. Surrogates used to proxy for subjective considerations in the optioning decision were significantly different from one another in the expected direction. Stocks that were optioned over the test period tended to have greater price volatility, greater market values, and were more actively traded than stocks that were not optioned.
Table 1
Parameter Estimates From Logit Regression

<table>
<thead>
<tr>
<th>Variable</th>
<th>β</th>
<th>Wald</th>
<th>Significance</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1</td>
<td>.2282</td>
<td>43.7284</td>
<td>.0000***</td>
<td>.2438</td>
</tr>
<tr>
<td>X2</td>
<td>1.8125</td>
<td>65.2606</td>
<td>.0000***</td>
<td>.3001</td>
</tr>
<tr>
<td>X3</td>
<td>3641.993</td>
<td>69.5059</td>
<td>.0000***</td>
<td>.3100</td>
</tr>
<tr>
<td>Constant</td>
<td>-40.7211</td>
<td>72.2848</td>
<td>.0000***</td>
<td></td>
</tr>
</tbody>
</table>

*** Significant at the 1% level.

X1 = Percent of outstanding shares traded
X2 = Natural log of market value of equity
X3 = Variance of stock price

This table presents parameter estimates from the Logit regression under the column labeled "β".

The Wald test statistic is also presented for each variable, as is the level of significance.

The R statistic shows the partial correlation between probability of optioning and the independent variables.
Table 2

Classification Table

Test Sample

<table>
<thead>
<tr>
<th>Observed</th>
<th>Predicted</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EVENT</td>
<td>NO EVENT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EVENT</td>
<td>163</td>
<td>48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO EVENT</td>
<td>30</td>
<td>279</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>193</td>
<td>327</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>211</td>
<td>309</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sensitivity = 77.3%
Specificity = 90.3%
Correct = 85.00%
False Positive Rate = 15.5%
False Negative Rate = 14.7%

Classification Table

Holdout Sample

<table>
<thead>
<tr>
<th>Observed</th>
<th>Predicted</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>EVENT</td>
<td>NO EVENT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EVENT</td>
<td>54</td>
<td>15</td>
<td></td>
<td></td>
</tr>
<tr>
<td>NO EVENT</td>
<td>7</td>
<td>96</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>61</td>
<td>111</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>69</td>
<td>103</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Sensitivity = 78.3%
Specificity = 93.2%
Correct = 87.2%
False Positive Rate = 10.9%
False Negative Rate = 13.9%

NOTE: An EVENT represents introduction of options.
Table 3
Comparison of Independent Variables for Optioned and Nonoptioned Portfolios Nonparametric Test Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean of Variable (Optioned)</th>
<th>Mean of Variable (Nonoptioned)</th>
<th>2-Sample T-test T-Value</th>
<th>Median Test Chi-Square</th>
<th>Mann-Whitney Z-value</th>
<th>K-S Z-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1</td>
<td>16.3%</td>
<td>4.3%</td>
<td>-16.13***</td>
<td>200.89***</td>
<td>-15.3110***</td>
<td>7.44***</td>
</tr>
<tr>
<td>X2</td>
<td>$497MM</td>
<td>$598.6MM</td>
<td>-0.80^</td>
<td>0.96</td>
<td>-1.4312</td>
<td>1.69***</td>
</tr>
<tr>
<td>X3</td>
<td>0.0014</td>
<td>0.0004</td>
<td>-17.27***</td>
<td>200.89***</td>
<td>-16.3888***</td>
<td>7.64***</td>
</tr>
</tbody>
</table>

*** Significant at the 1% level
^ The natural logarithm of this variable was used for 2-sample T-test.

X1 = Percent of outstanding shares traded
X2 = Market value of equity
X3 = Variance of stock price

The 2-sample t-test indicates whether means of the variables for the two portfolios are equal.

The median test indicates whether medians of the variables for the two portfolios are equal.

Mann-Whitney and Kolmogorov-Smirnov help determine whether distribution functions of the two samples are equal.
ESSAY II

TESTING THE RELATIONSHIP BETWEEN PROBABILITY OF OPTION INTRODUCTION AND PRICE RESPONSE TO OPTION INTRODUCTION

INTRODUCTION TO THE STUDY

Relative predictability of option introduction was evaluated in the first section of this dissertation. Using firm-specific variables, a LOGIT model was developed that allowed us to predict with about 85 percent accuracy which firms would have equity options introduced. Based on that model, we rejected the null hypothesis that introduction of equity options is not predictable.

The impetus for the second part of this study is previous research that indicates introduction of equity options is often accompanied by an increasing stock price. If the probability of optioning can be inferred from publicly available information, we would expect to see a relationship between the ex ante probability of optioning and abnormal returns observed in the event window around the optioning date. That is, in an efficient market, a stock with a high probability of being optioned would be expected to show less price response to optioning than would a stock with a low probability of being optioned. This assumes option introduction is associated with a changing stock price.
Firms that had equity options introduced over the test period noted in the first part of the study form a sample that is used here for further analysis. The goal is to compare abnormal returns associated with option introduction based on the predicted probability of optioning. The sample is divided into three portfolios based on relative probability of option introduction. Abnormal returns are determined for the portfolios, and hypotheses regarding relationships among those abnormal returns are tested.

Regression analysis was performed on two portfolios formed on the basis of probability of optioning. Independent variables in the equation included the predicted probability of optioning and a dummy variable indicating whether the stock was in the portfolio with the higher or lower probability of optioning. Abnormal returns were the dependent variable.

This part of the dissertation therefore involves statistical analysis to determine the strength of the relationship between the probability of being optioned and the price response following option introduction. This will help determine whether the market assesses the probability of a stock being optioned and whether this affects stock valuation.
LITERATURE REVIEW

Option Listing:

Initiation of option trading is normally accompanied by abnormal positive returns in the underlying stock. Branch and Finnerty (1981) detected an average relative price rise of 5.2 percent near the time of option listing. Haddad and Voorheis (1991) noted that, on the day of option introduction, the average excess return is positive and significant at the .05 level. Testing all options introduced from 1973 through 1987, Kim and Young (1991) found strongly significant abnormal returns on the day options trading began. Conrad (1989) found introduction of an options market to be associated with a positive price effect on the underlying security beginning about three days before the date of option introduction.

Although Rao and Ma (1987) found negative excess returns on announcement day, they observed positive excess returns on the day option trading actually began. Introduction of options is announced about five days before the introduction date.

In contrast, Klemkosky and Maness (1980) found risk-adjusted returns to be slightly negative in response to option introduction. Whiteside, Dukes, and Dunne (1983) determined that announcement period returns are insignificant.
The majority of research findings therefore support the contention that option introduction produces a positive price response. Several reasons have been set forward to explain this response. Kim and Young (1991) suggest that option introduction helps to complete the market. This expands the set of feasible returns available to investors, increasing the welfare of shareholders, leading to an increased share price.

Rao, Tripathy, and Dukes (1991) state that options attract additional participants into the market and increase efficiency of the market through reduced price variance. Rao and Ma (1987) contend that availability of options attracts new investors as a result of expanded risk-return opportunities of the underlying stocks. This increased demand for the stock produces upward pressure on the stock price. Bansal, Pruitt, and Wei (1989), Branch and Finnerty (1981), and Haddad and Voorhies (1991) support the contention that the price effect results from an increased demand for the stock.

Conrad (1989) attempts to explain why there would be an increased demand for the stock. Dealers and floor traders may build up their inventory of stock in preparation for hedging call options on the stock. This view is substantiated by the finding that the price response Conrad detected is positively correlated with open interest in the underlying security during the same period.
According to the law of supply and demand, an increased demand for the stock would be expected to lead to a higher stock price. This expectation was tested by Harris and Gurel (1986). Examining shifts in demand associated with changes in the S&P 500 list, they found that these changes led to a large increase in volume. Increasing volume was accompanied by a statistically significant increase in stock price.

Market Efficiency:

A thorough literature review of market efficiency is presented in the third essay of this dissertation. There are also market efficiency implications for this study. Efficient markets theory suggests that, if option introduction produces a positive price response, stocks with a lower probability of being optioned should show a greater price response around option introduction than stocks with a higher probability of being optioned. This is similar to the work undertaken by Schadler and Moore (1992). They found that firms with a lower probability of issuing new equity had greater abnormal returns following issuance of equity than did firms with a higher probability of issuing equity.

The objective here is similar to that of Schadler and Moore (1992). We want to determine whether the predicted
probability of option introduction from the first essay is related to abnormal returns around option introduction.

MOTIVATION FOR THE STUDY

This study is an extension of findings in the first essay. It was determined there that, for the time period in question, the probability of equity option introduction could be determined by observation of certain firm-specific variables. That finding is used here to test market efficiency theory.

The idea of market efficiency pervades much of finance research. Fama (1991) reviewed extant research on market efficiency. In the 1991 paper, he revised his previous (1970) system of classifying tests of market efficiency. Under the new classification scheme, semi-strong tests of market efficiency were renamed 'event studies'. Fama stresses that event studies using daily data attenuate or eliminate the joint hypothesis problem. That is, we are no longer testing the model used to estimate 'normal' returns, and we can test directly the impact of an event on stock returns.

With this in mind, event study techniques are used to test the response of stock prices to optioning of the stock. First it was determined which stocks optioned on or after October 21, 1991 had adequate return data on the CRSP tapes for performance of an event study. The LOGIT model
developed in Essay One was then used to determine the a priori probability of each of these stocks being optioned. Appropriate statistical tests were then used to determine the relationship between probability of optioning and abnormal returns.

HYPOTHESIS

The research question addressed in this essay is whether capital markets efficiently incorporate the probability of option introduction into stock prices. The null and alternative hypotheses may be stated as:

\( H_0 \): There is no significant difference between abnormal returns of portfolios of stocks, formed on the basis of probability of optioning, in event windows surrounding option introduction.

\( H_A \): Portfolios of stocks, formed on the basis of probability of option introduction, will have significantly different abnormal returns in event windows surrounding option introduction.

DATA

Data items required in this study grew out of certain aspects of finance theory. The goal was to identify variables that would be expected to influence stock returns. The ratio of book value to market value and the price-earnings ratio were shown by Fama and French (1992) to have
a strong cross-sectional relation to stock returns. Ou and Penman (1989) combined 68 financial items into one summary measure in order to get an indication of one-year-ahead earnings changes. Using a LOGIT model, 16 descriptors were identified that were significant at the 10 percent level. Of these 16 variables, three were chosen for consideration in the current study. These were debt/equity ratio, average change in current ratio, and average change in sales. Of the 16 variables in the Ou and Penman model, the three used here are expected to have the greatest predictive ability for returns. Other variables in the Ou and Penman model, such as change in depreciation and ratio of sales to total cash would be less likely to explain returns.

Data items were obtained from the Compustat data bases. They were calculated as a quarterly average over the entire test period (October 1991 through December 1993).

A listing of stocks that had equity options introduced over the test period was obtained from the statistical department of the Chicago Board Options Exchange. Return data for use in the event studies were obtained from the Center for Research in Security Prices (CRSP) daily returns tape. The probability of option introduction was determined from the LOGIT model developed in essay one.

SAMPLE

The initial sample consisted of stocks from the sample used in the first essay that had equity options introduced
between October 21, 1991 and December 31, 1993. There were 280 firms in that sample. Firms that lacked additional data items noted in the data section above were eliminated from the initial sample. Also eliminated were firms with contaminating events during the event period. This led to a sample of 192 firms for analysis in the current essay.

The sample was partitioned based on predicted probability of optioning. Three portfolios were formed. One consists of firms with the highest probability of optioning, one consists of firms with the lowest probability, and one consists of firms with an intermediate probability. Abnormal returns were determined for each of these portfolios. These abnormal returns were then compared using nonparametric statistics.

The sample was also used in a multiple regression, using abnormal returns as the dependent variable. However, the sample was divided into two rather than three portfolios for this analysis. The original sample of 192 firms was sorted on predicted probability of optioning. The two portfolios consisted of the eighty firms with the highest (lowest) probabilities of optioning. This procedure was intended to eliminate firms with an intermediate probability of optioning in order to make a clearer distinction in the regression analysis.
METHODOLOGY:

Event Study:

Standard event study methodology was used to determine abnormal returns for each portfolio and for the entire sample. Event day for each stock was the day of option introduction. The event study is that used by Schadler and Moore (1992) and by Mikkelson and Partch (1986). The single index market model parameters were estimated over 255 days, ending 46 days prior to commencement of options trading. That model is:

\[ R_{jt} = \alpha_j + \beta_j R_{mt} + \epsilon_{jt} \]  

where \( R_{jt} \) = return on security \( j \) on day \( t \),

\( R_{mt} \) = return on the CRSP equally-weighted market index on day \( t \),

\( \alpha_j, \beta_j = \) regression parameters,

\( \epsilon_{jt} = \) mean-zero error term on day \( t \).

The parameters of (13) are estimated by ordinary least squares regression. Prediction errors are then calculated as

\[ PE_{jt} = R_{jt} - (\hat{\alpha}_{jt} + \hat{\beta}_j R_{mt}) \]  

where coefficients \( \hat{\alpha}_j \) and \( \hat{\beta}_j \) are OLS estimates of \( \alpha_j \) and \( \beta_j \).

Prediction errors were calculated for each day in the period \( T-3 \) through \( T+1 \), with \( T \) representing the day options
were introduced. Prediction errors were also cumulated over various intervals around option introduction.

Regression Analysis:

Independent variables used in regression analysis include the estimated probability of optioning, the ratio of book value to market value, debt/equity ratio, price-earnings ratio, average change in current ratio, and average change in sales. Also included was a dummy variable coded 0 or 1. Stocks in the portfolio with the higher (lower) probability of optioning were coded 0 (1). Prediction errors, or abnormal returns, obtained from the event studies, were used as the dependent variable. Parameter estimates for each of the independent variables were obtained by ordinary least squares regression. Backward stepwise elimination was used to eliminate insignificant variables. The regression equation is

$$\text{CAR}_n = \beta_1 D + \beta_2 P + \beta_3 X_1 + \beta_4 X_2 + \beta_5 X_3 + \beta_6 X_4 + \beta_7 X_5$$

where

- $D$ = Dummy variable coded 0 or 1
- $P$ = Predicted probability of optioning (from Essay One)
- $X_1$ = Ratio of book value to market value
- $X_2$ = Price/earnings ratio
- $X_3$ = Average change in current ratio
- $X_4$ = Average change in sales
- $X_5$ = Debt/equity ratio
If the null hypothesis under consideration is invalid, the parameter estimate associated with the probability of option introduction should have statistical significance. The parameter estimate associated with the dummy variable would also be expected to be significant. Parameter estimates and $t$-tests were examined for significance to determine whether this is the case.

Comparison of Abnormal Returns:

Nonparametric statistical measures were applied to determine whether abnormal returns differed among the three portfolios. Tests include a multiple sample median test and the Kruskal-Wallis one-way ANOVA.

The median test was used in other sections of this dissertation to determine whether two samples came from populations having the same median. Here it is applied to determine whether abnormal returns for the three portfolios have the same median. The test statistic used in the median test is

$$ T = \sum_{i=1}^{c} \frac{(O_{i1} - O_{i2})^2}{n_i} $$

(16)
where

\[ O_{1i} = \text{observations from population } i \text{ classified as class 1}, \]
\[ O_{2i} = \text{observations from population } i \text{ classified as class 2}, \]
\[ c = \text{the number of populations, and} \]
\[ n_i = \text{the number of observations in population } i. \]

The critical region of approximate size \( \alpha \) corresponds to values of \( T \) greater than \( x_{1-\alpha} \), the \((1-\alpha)\) quantile of a chi-square random variable with \( c-1 \) degrees of freedom. If \( T \) exceeds \( x_{1-\alpha} \), reject the hypothesis that all populations have the same median.

The Kruskal-Wallis test is an extension of the Mann-Whitney two sample test. This test allows us to test whether \( k \) random samples come from identical populations. The three samples are combined into one sample and each observation is assigned a rank. A rank of 1 represents the smallest observation, and \( N \) represents the largest observation (and the total sample size). Ranks for all observations in each sample are summed. Let \( R_i \) represent the sum of all ranks for sample \( i \), with \( i=1, 2, 3 \). We can then test the null hypothesis that all three population distribution functions are identical using the test statistic:

\[
T = \frac{12}{N(N+1)} \sum_{i=1}^{k} \frac{R_i^2}{n_i} - 3(N+1) \tag{17}
\]
\(N\) and \(R_i\) are as previously defined and \(n_i\) is the number of observations in the \(i^{th}\) sample. We can reject \(H_0\) at the \(\alpha\) level if \(T\) exceeds the \(1-\alpha\) quantile obtained from the appropriate table.

RESULTS

Event Study:

A sample was obtained and divided into portfolios as discussed previously. Event studies were performed on each of the portfolios and on the total sample. Results for the total sample are found in Table 1.

Results on the full-sample event study were enlightening. Of the event windows examined, none was found to exhibit significant abnormal positive returns. For the event window that included the event day and day \(T+1\) and for days \(T-3\) and \(T+1\), significant abnormal negative returns were detected.

This finding conflicts with most previous research concerning option introduction. However, some researchers have obtained similar results. Whiteside, Dukes, and Dunne (1983) found announcement period returns to be insignificant. Kim and Young (1991) found that the price impact of option listing had declined in recent years. They found significant abnormal returns for their entire sample, which covered the period from April 26, 1973 to July 31, 1987. They then partitioned their sample around the 1977
option listing moratorium. They found no significant abnormal returns associated with option listing in the period following the moratorium.

Event studies were then performed on each of the three portfolios. The goal here was to determine whether any of the portfolios showed significant abnormal returns.

Table 2 presents results of event studies for each of the three portfolios. Abnormal returns for the portfolios with highest and intermediate probability of optioning did not differ significantly from zero except on day T-3. The portfolio with the lowest probability of optioning showed negative abnormal returns for event window 0 to +1 and for day T+1.

Regression Analysis:

Regression analysis was performed using the two portfolios described in the sample section above. Each of the abnormal returns was regressed on the independent variables listed in the procedure section above. Backward stepwise elimination was used to delete variables that lacked significance. All independent variables were removed from the equation through the backward elimination. That is, none of the variables contributed significantly to the model's ability to predict abnormal returns.
Comparison of Abnormal Returns:

Nonparametric tests were performed as defined in the data section above. The median test detected no significant differences among abnormal returns of the three portfolios for any event window. Thus we cannot say the medians for any combination of the three portfolios are different from one another. Table 3 presents results of the median test. Results of the Kruskal-Wallis test are presented in Table 4. This test revealed no significant difference among the three portfolios for any event window. Thus we cannot say that there is a significant difference between distribution functions for any pairing of the samples.

INTERPRETATION

Event study results indicate that abnormal returns associated with option introduction have very little significance (see Table 1). The only significance was found on days T-3 and T+1. Those abnormal returns were negative. Negative returns around option introduction seems counterintuitive. This finding is also in conflict with most research regarding effects of option introduction. Rao and Ma (1987) suggested that option introduction may destabilize the market by encouraging speculation, leading to negative wealth effects. Results here support this conclusion. Abnormal returns on day T-3 would be around the date option listing was announced. This may indicate that investors have begun to view option listing as a negative sign. This
may result from indiscriminate listing of options in recent years. That is, due to the low cost of option introduction, an options exchange may introduce options on a stock just to find out if there is a demand for it. If there is no market, the exchange can delist the option with little harm done.

The negative return on the day following option introduction is interesting. By that time, investors have known for several days that the option would be introduced. However, on the day following listing, returns are negative. This indicates there is no longer an increased demand associated with option introduction and that investors are reacting negatively to the introduction.

Nonparametric comparison of abnormal returns shows the differences are not statistically significant. In addition, none of the variables expected to have significant explanatory power in a regression showed significance.

Overall results for essays one and two indicate that stock option introduction was predictable over the test period. However, abnormal returns associated with option introduction were not correlated with the probability of introduction or with a dummy variable indicating a higher or lower probability of option introduction.

The low level of significant abnormal returns in event windows around option introduction supports the findings of Whiteside, Dukes, and Dunne (1983). They concluded that
announcement period returns are insignificant. This finding contradicts the works of Branch and Finnerty (1981), Conrad (1989), and Haddad and Voorheis (1991). These researchers detected abnormal positive returns around the date of option introduction.

Findings regarding efficient market theory are inconclusive. Stocks with a lower probability of stock introduction seem to have more significant abnormal returns around option introduction than those with a higher probability. However, the difference is not statistically significant, and variables used in this study were not associated with abnormal returns in a regression analysis.
## Table 1

Event Study Results

**Full Sample**

<table>
<thead>
<tr>
<th>Day or Interval</th>
<th>Mean CPE</th>
<th>Cumulative Z</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3 to 0</td>
<td>-1.33%</td>
<td>-1.07</td>
</tr>
<tr>
<td>-2 to 0</td>
<td>-0.38%</td>
<td>0.16</td>
</tr>
<tr>
<td>-1 to 0</td>
<td>-0.15%</td>
<td>0.49</td>
</tr>
<tr>
<td>-1 to +1</td>
<td>-0.40%</td>
<td>-0.70</td>
</tr>
<tr>
<td>0 to +1</td>
<td>-0.64%</td>
<td>-1.76*</td>
</tr>
<tr>
<td>0</td>
<td>-0.16%</td>
<td>-0.59</td>
</tr>
<tr>
<td>-3</td>
<td>-0.55%</td>
<td>-2.43**</td>
</tr>
<tr>
<td>-2</td>
<td>-0.29%</td>
<td>-0.42</td>
</tr>
<tr>
<td>-1</td>
<td>0.15%</td>
<td>1.28</td>
</tr>
<tr>
<td>+1</td>
<td>-0.56%</td>
<td>-1.90*</td>
</tr>
</tbody>
</table>

Mean CPE = mean cumulative prediction error

* Significant at the 10 percent level.
** Significant at the 5 percent level.
Table 2
Cumulative Prediction Errors and Significance Levels for all Portfolios and all Event Windows

<table>
<thead>
<tr>
<th>Day or Interval</th>
<th>Highest Probability</th>
<th>Intermediate Probability</th>
<th>Lowest Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean CPE</td>
<td>Cumulative Z</td>
<td>Mean CPE</td>
</tr>
<tr>
<td>-3 to 0</td>
<td>-2.07%</td>
<td>-0.53</td>
<td>-1.70%</td>
</tr>
<tr>
<td>-2 to 0</td>
<td>-0.64%</td>
<td>0.54</td>
<td>-0.57%</td>
</tr>
<tr>
<td>-1 to 0</td>
<td>-0.06%</td>
<td>0.79</td>
<td>-0.57%</td>
</tr>
<tr>
<td>-1 to +1</td>
<td>-0.42%</td>
<td>-0.14</td>
<td>-0.69%</td>
</tr>
<tr>
<td>0 to +1</td>
<td>-1.12%</td>
<td>-0.45</td>
<td>-0.76%</td>
</tr>
<tr>
<td>0</td>
<td>-0.18%</td>
<td>0.72</td>
<td>-0.31%</td>
</tr>
<tr>
<td>-3</td>
<td>-0.98%</td>
<td>-2.01**</td>
<td>-0.48%</td>
</tr>
<tr>
<td>-2</td>
<td>-0.89%</td>
<td>-0.18</td>
<td>-0.50%</td>
</tr>
<tr>
<td>-1</td>
<td>0.45%</td>
<td>0.40</td>
<td>-0.07%</td>
</tr>
<tr>
<td>+1</td>
<td>-1.03%</td>
<td>-1.35</td>
<td>-0.43%</td>
</tr>
</tbody>
</table>

Mean CPE = mean cumulative prediction error

* Significant at the 10 percent level
** Significant at the 5 percent level
Table 3

Results of Median Test**

** Charts indicate number of returns in each portfolio that are greater than or less than/equal to the grand median.

Cumulative Abnormal Return for T-3 to 0:

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>1'</th>
<th>2'</th>
<th>3'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gt Median</td>
<td>32</td>
<td>25</td>
<td>38</td>
</tr>
<tr>
<td>Le Median</td>
<td>32</td>
<td>39</td>
<td>26</td>
</tr>
</tbody>
</table>

Cases  Median  Chi-Square  D.F.  Significance
192  -.015  5.2922  2  .0709

Cumulative Abnormal Return for T-2 to 0:

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>1'</th>
<th>2'</th>
<th>3'</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gt Median</td>
<td>32</td>
<td>26</td>
<td>38</td>
</tr>
<tr>
<td>Le Median</td>
<td>32</td>
<td>38</td>
<td>26</td>
</tr>
</tbody>
</table>

Cases  Median  Chi-Square  D.F.  Significance
192  .000  4.5000  2  .1054

* Portfolio 1 has the highest probability of optioning.
  Portfolio 2 has the intermediate probability of optioning.
  Portfolio 3 has the lowest probability of optioning.
Table 3 (cont.)

Results of Median Test

Cumulative Abnormal Return for T-1 to 0:

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gt Median</td>
<td>33</td>
<td>28</td>
<td>35</td>
</tr>
<tr>
<td>Le Median</td>
<td>31</td>
<td>36</td>
<td>29</td>
</tr>
</tbody>
</table>

Cases | Median | Chi-Square | D.F. | Significance |
------|--------|------------|------|--------------|
192   | .001   | 1.6250     | 2    | .4437        |

Cumulative Abnormal Return for 0 to T+1:

<table>
<thead>
<tr>
<th>Portfolio</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gt Median</td>
<td>31</td>
<td>28</td>
<td>37</td>
</tr>
<tr>
<td>Le Median</td>
<td>33</td>
<td>36</td>
<td>27</td>
</tr>
</tbody>
</table>

Cases | Median | Chi-Square | D.F. | Significance |
------|--------|------------|------|--------------|
192   | -.005  | 2.6250     | 2    | .2691        |

* Portfolio 1 has the highest probability of optioning. Portfolio 2 has the intermediate probability of optioning. Portfolio 3 has the lowest probability of optioning.
Table 4

Results of Kruskal-Wallis One-Way Anova**

** Results show the mean rank for returns in each portfolio. Chi-square statistic indicates whether there is a difference between means of at least two portfolios.

Cumulative Abnormal Return for \(T-3\) to 0:

<table>
<thead>
<tr>
<th>Mean Rank</th>
<th>Cases</th>
<th>(Y =)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>128.81</td>
<td>64</td>
<td>1</td>
<td>Highest probability.</td>
</tr>
<tr>
<td>125.37</td>
<td>64</td>
<td>2</td>
<td>Intermediate probability.</td>
</tr>
<tr>
<td>151.00</td>
<td>64</td>
<td>3</td>
<td>Lowest probability.</td>
</tr>
</tbody>
</table>

Corrected for Ties

<table>
<thead>
<tr>
<th>CASES</th>
<th>Chi-Square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>192</td>
<td>3.5700</td>
<td>.1678</td>
</tr>
</tbody>
</table>

Cumulative Abnormal Return for \(T-2\) to 0:

<table>
<thead>
<tr>
<th>Mean Rank</th>
<th>Cases</th>
<th>(Y =)</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>134.28</td>
<td>64</td>
<td>1</td>
<td>Highest probability.</td>
</tr>
<tr>
<td>124.95</td>
<td>64</td>
<td>2</td>
<td>Intermediate probability.</td>
</tr>
<tr>
<td>145.89</td>
<td>64</td>
<td>3</td>
<td>Lowest probability.</td>
</tr>
</tbody>
</table>

Corrected for Ties

<table>
<thead>
<tr>
<th>CASES</th>
<th>Chi-Square</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>192</td>
<td>2.7675</td>
<td>.2506</td>
</tr>
</tbody>
</table>
Table 4 (cont.)

Results of Kruskal-Wallis One-Way Anova

<table>
<thead>
<tr>
<th>Cumulative Abnormal Return for T-1 to 0:</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Rank</td>
<td>Cases</td>
<td>Y = 1</td>
<td>Y = 2</td>
<td>Y = 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>140.94</td>
<td>64</td>
<td>Highest probability.</td>
<td></td>
<td>125.48</td>
<td>64</td>
<td>Intermediate probability.</td>
</tr>
<tr>
<td>Corrected for Ties</td>
<td>CASES</td>
<td>Chi-Square</td>
<td>Significance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>192</td>
<td>0.9189</td>
<td>.6316</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Cumulative Abnormal Return for 0 to T+1:</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean Rank</td>
<td>Cases</td>
<td>Y = 1</td>
<td>Y = 2</td>
<td>Y = 3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>142.46</td>
<td>64</td>
<td>Highest probability.</td>
<td></td>
<td>125.39</td>
<td>64</td>
<td>Intermediate probability.</td>
</tr>
<tr>
<td>Corrected for Ties</td>
<td>CASES</td>
<td>Chi-Square</td>
<td>Significance</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>192</td>
<td>1.0040</td>
<td>.6053</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
month-end market value of equity was determined for the nonoptioned sample over the entire test period.

Daily price variance for the optioned sample was determined over the year prior to option introduction. Variance was determined for the nonoptioned sample over the entire test period. For the optioned sample, daily variance in the month before optioning was also determined and was used for statistical modeling.

Number of cites in the *Wall Street Journal* was determined for the optioned sample in the twelve-month period ending the month before option introduction. For the nonoptioned sample, the average annual number of cites was determined for years 1992 and 1993.

The institutional holding variable for the optioned sample is the percentage of outstanding common shares held by institutions at the end of the month prior to optioning. For the nonoptioned sample, institutional holding is the average of institutional holding at the beginning and the end of the test period.

A holdout sample was used to test the model. This sample included approximately 25 percent of the firms in both the optioned and nonoptioned groups. The holdout sample therefore consists of 69 optioned firms and 103 nonoptioned firms randomly selected from the final sample of 280 optioned stocks and 412 nonoptioned stocks. The
remaining 211 optioned stocks and 309 nonoptioned stocks were used to develop the LOGIT model.

METHODOLOGY

All data items mentioned in the data section above were obtained for optioned and nonoptioned firms. The surrogates related to volatility, name recognition, liquidity, and institutional holding were then used as independent variables in a LOGIT regression. The dependent variable was a binomial dummy variable used to connote whether or not a stock was optioned. The backward elimination procedure in LOGIT was used to determine which of the variables under consideration were statistically significant in determining the probability of optioning.

The LOGIT Model:

In determining which statistical technique to use to develop the model, the two main contenders were LOGIT and multiple discriminant analysis (MDA). Kennedy (1992) states that LOGIT is preferable to MDA in analyses such as the one in this study. MDA relies on the unreasonable assumption that characteristics of the firms can be viewed as being distributed multivariate-normally with a different mean vector (but the same variance-covariance matrix) associated with the binomial dependent variable. LOGIT was therefore chosen for use in this study.
ESSAY III

MARKET EFFICIENCY AND THE AVAILABILITY OF EQUITY OPTIONS:
THE CASE OF DIVIDEND CHANGES

INTRODUCTION TO THE STUDY

Numerous researchers have attempted to determine whether informed traders divert their trading activities into the options market when options are available on a stock. Evidence indicates that information-based trading occurs frequently in the options market.

If informed traders are trading options, the question arises whether introduction of an options market increases informational efficiency in the underlying security. If so, the process of efficient security pricing should be enhanced as informed traders bring their demands into the marketplace through the options market.

Several researchers and theoreticians have endeavored to explain why these demands can be introduced into the marketplace more easily through options markets than through markets for the underlying securities. This has led to a branch of literature that differentiates investment opportunities in stocks from those in options. Basically, researchers argue that impediments to trading in stocks, such as restrictions on short sales and higher margin requirements, are not present in the options market. This
allows informed traders to bring their demands to the market more quickly, increasing informational efficiency.

We therefore have both theoretical and empirical evidence that information-motivated traders trade in both the options market and the stock market. Thus the options market may be viewed as providing an alternative venue whereby information is communicated to the markets.

If this is actually the case, one would expect prices of optioned stock to reflect inside information more fully than do prices of nonoptioned stocks. Jennings and Starks (1986) tested this theory using earnings announcements and found that prices of nonoptioned stocks took longer to adjust to information contained in earnings announcements than did prices of optioned stocks. Skinner (1990) noted that abnormal returns around earnings announcements were greater for nonoptioned stocks than for optioned stocks. Sarkar and Tripathy (1994) found less price response to intensive insider trading in optioned stocks than in nonoptioned. These findings indicate that existence of the options market leads to greater informational efficiency in optioned stocks.

Event study techniques have been employed to test price response to a wide variety of events. Several events have been identified which produce a marked stock price response. One of the most thoroughly documented of these is the price response to announcement of dividend changes. In the sequel
to his 1970 pioneering work in efficient capital markets, Fama (1991) noted that announcements of dividend changes are normally associated with stock price responses of the same sign as the dividend change. This phenomenon has led to development of the dividend signalling hypothesis. The upshot of this hypothesis is that, since dividends are almost solely at the discretion of management, they provide the clearest signal that management can impart regarding anticipated future earnings. Earnings announcements, being subject to wide variability due to effects of accounting principles, send a murkier signal to the markets.

Thus, we have seen that dividend announcements have a well-documented price effect of the same sign as the dividend change. We also see that dividends are one of the clearest signals management can use to convey information to the markets. As the third part of this dissertation, these findings were used to test whether pricing is more efficient for optioned stocks than for nonoptioned stocks. If options trading increases informational efficiency, one would expect any information contained in dividend announcements to be more quickly incorporated into the price of optioned stocks than nonoptioned stocks. In the spirit of the Skinner (1990) paper, this paper represents a comparison of the price response of optioned stocks and nonoptioned stocks to announced dividend changes.
LITERATURE REVIEW

Market Efficiency:

Several researchers have tried to determine whether markets are more informationally efficient for optioned stocks than for nonoptioned stocks. Diamond and Verrecchia (1987) modeled the effects of constraints on short-sales on the distribution and speed of adjustment of security prices. They determined that option introduction increases the speed of price adjustments to private information.

Fededia and Grammatikos (1992) and Rao, Tripathy and Dukes (1991) found that the bid-ask spread (BAS) decreases significantly following initiation of option trading. As Stoll (1989) noted, the size of the BAS is an indirect measure of the amount of informational asymmetry related to a stock. Stoll also showed that more than 40 percent of the BAS for over-the-counter stocks stems from brokers protecting themselves from potential losses to informed traders. We thus assume that a decrease in the BAS indicates an increase in informational efficiency.

Bansal, Pruitt and Wei (1989) noted an increase in trading volume on the underlying stock following option introduction. Rao, Tripathy and Dukes (1991) state that option introduction attracts additional participants into the market. This increased attention to the stock leads to an increase in efficiency through reduced information asymmetry and reduced price variance.
Insider Trading:

Of particular interest in recent research is the question of insider trading in options. That is, do informed traders divert their trading activity from the stock market to the options market? Researchers have determined that this may be the case.

Shortly after options began trading on an organized exchange in 1973, Black (1975) sought to explain why insiders might prefer to trade options. He demonstrated that transaction costs are lower when taking a position in options versus taking an equivalent position in the underlying stock.

Ross (1976) demonstrated theoretically that option introduction expands the returns space sufficiently to allow capital markets to become complete. Insiders would be expected to utilize these possibilities, leading to a gain in efficiency.

Manaster and Rendleman (1982) expanded on this by demonstrating several reasons investors may regard options as a superior vehicle. In addition to trading costs, they noted that the short-sale of options, unlike short-sale of stocks, is not governed by the uptick rule. Margin requirements may prohibit an investor from obtaining a desired amount of leverage in the stock, while desired leverage is attainable in the options market.
Informed traders may trade in options rather than stocks for any of the above reasons. Option prices may therefore reflect inside information not captured by observed stock prices. This would lead to arbitrage opportunities as implied stock prices differ from observed prices. Traders trying to profit from this mispricing will cause implied and observed stock prices to converge. Thus, option markets would make stock market pricing more efficient.

More recently, Easley, O'Hara, and Srinivas (1993) developed a model to predict whether informed traders would trade in options markets, stock markets, or both. They determined that for some parameter values, the equilibrium is one where informed traders only use stocks. However, if the leverage effect of options is large enough or if the liquidity in the stock is small, at least some informed traders will use options. They note that theory resulting from their model indicates that, under a wide variety of conditions, informed traders use both stock and option markets.

Back (1992) developed a model to show that the presence of informed trading in options may induce components in option returns that are independent of the underlying asset's returns. Sheikh and Ronn (1994), examining daily and intraday behavior of returns on options, concluded that
informed traders trade in both options and the underlying asset.

Theory therefore implies that informed traders might prefer to trade in options. The previously noted works of Jennings and Starks (1986), Skinner (1990), and Sarkar and Tripathy (1994) indicate that informed investors are indeed trading in the options market, leading to increased informational efficiency in optioned stocks. Since informed traders are bringing their demands, and therefore their information, to the markets through options trading, optioned stocks may be priced more efficiently.

Meulbroek (1992), investigating incidents of illegal insider trading, found that insiders employed options in more than half the instances where options were available. Sarkar and Tripathy (1994) sought to determine where insiders trade by measuring the amount of insider trading in optioned versus nonoptioned stocks and by measuring price reaction to insider trading in the two groups. As a proportion of total trading volume, optioned stocks experienced a lower incidence of insider trading. While stock prices for both optioned and nonoptioned stocks increased during months of intensive insider trading in the stock, the magnitude of the price reaction was significantly smaller for the optioned firms. These findings are consistent with the view that informed trading is more
likely to occur in the options market than in the underlying stock market.

Easley, O'Hara, and Srinivas (1993) tested whether trading volume in the options market had an impact on stock prices. They segregated option trades based on whether they would benefit from a stock price increase or stock price decrease. They observed that option volume had a strong effect on stock prices. This finding is consistent with option markets being a venue for information-based trading.

Dividend Changes:

Given that informed traders trade in options markets, the existence of traded options should increase efficiency. To test whether this is the case, we can compare the price response of optioned and nonoptioned stocks to an event. For this exercise, it is preferable to use an event that is known to have a marked price effect. Announcement of dividend changes is a likely candidate for this role.

Miller and Modigliani (1961) contended that, in frictionless markets, dividend payments are irrelevant. However, Fama (1991) noted that changes in dividend payments often produce a marked share price response of the same sign as the change.

Finding of abnormal returns associated with dividend announcements has led to a branch of literature dealing with the "information content" of dividends. Bhattacharya (1979)
developed a theoretical model to show that when shareholders have imperfect information about firms' profitability, dividends will function as a surrogate for a signal of expected cash flows. Pettit (1972) noted that management has a fear of reducing or omitting dividends and a desire to delay increasing dividends until the level of cash flows can be estimated with little uncertainty.

Woolridge (1983) demonstrated that the primary factor influencing returns in response to dividend changes is market signalling. Laub (1976) concluded that dividend announcements convey information about future earnings prospects not contained in past earnings.

Kalay (1980) contends that managerial aversion to reduce dividends is the basis for the information content of dividends hypothesis. Miller and Rock (1985) stated that dividend announcement effects are thoroughly documented, implying that information asymmetry between investors and managers clearly exists.

Asquith and Mullins (1983) used initial payment of dividends and subsequent dividend increases to demonstrate a positive relationship between dividend changes and stock returns. Morgan (1982) further substantiated this relationship by testing portfolios of high-yield, low-yield and zero-yield stocks.

Dielman and Oppenheimer (1984) tested four samples: dividend initiating, 25 percent increase, 25 percent
decrease, and dividend omitting. Expected results were found on all four samples.

Bajaj and Vijh (1990) found price reactions to dividend increases and decreases are more remarkable for high dividend yield stocks. Impson and Karafiath (1992) noted strong negative returns associated with dividend decreases. Several researchers have found the anticipated price response to be more pronounced for dividend decreases than for dividend increases [for example, Charest (1978), Woolridge (1982), Benesh, Keown, and Pinkerton (1984), and Gosh and Woolridge (1988)].

Others have demonstrated that simultaneous announcement of earnings and dividends has a corroborative effect on the price response. Aharony and Swary (1980) contend that, since dividend decisions are almost solely at management's discretion, dividend changes provide a less ambiguous signal than do earnings numbers. Kane, Lee and Marcus (1984) note a statistically significant interaction effect between earnings and dividend announcements when the two occur within a few days of each other. Gosh and Woolridge (1988) found that contemporaneous announcement of poor earnings and dividend decreases exacerbated capital losses.

The consensus is that a positive correlation exists between dividend changes and stock returns. Considering these findings, comparing the price response of optioned and
nonoptioned stocks to dividend changes may shed light on the market efficiency aspect of option introduction.

MOTIVATION FOR THE STUDY

As noted previously, researchers have recently sought to determine whether existence of traded options on a stock leads to greater informational efficiency in the market for that stock [Sarkar and Tripathy (1994), Easley, O'Hara and Srinivas (1993), Jennings and Starks (1986) and Skinner (1990)]. Jennings and Starks (1986) and Skinner (1990) compared the response of optioned and nonoptioned stocks to earnings announcements. Sarkar and Tripathy (1994) compared the response of those two groups to episodes of intensive insider trading. Results in each of these studies support the hypothesis that availability of options increases efficiency.

This increased efficiency hypothesis is tested in another manner in this essay. Specifically, the response of optioned stocks and nonoptioned stocks to announcement of significant dividend changes are compared. If the optioned stocks are more informationally efficient, they would be expected to show less price response to dividend changes. This may result from informed traders communicating information through the options market.

This study may also contribute to our understanding of the dividend signalling hypothesis. This hypothesis
suggests that dividend changes serve to communicate managements' beliefs concerning earnings prospects. If that is the case, and if existence of traded options increases informational efficiency, managers' need to communicate via dividend changes may be alleviated. In that case, we may expect dividend changes for firms with no traded options to be of greater magnitude than dividend changes for firms with traded options.

HYPOTHESIS

The research question to be addressed in this essay is whether optioned stocks are priced more efficiently than nonoptioned stocks. The null and alternative hypotheses may be stated as:

$H_0$: There will be no significant difference between abnormal returns for optioned stocks and nonoptioned stocks following announced dividend changes.

$H_a$: Abnormal returns of nonoptioned stocks associated with announced dividend changes will be of a greater magnitude than abnormal returns of optioned stocks related to such announcements.

DATA

Data requirements for this study include dates of listing and delisting of options and dates and amounts of dividend changes. Stock prices were required to calculate
dividend yield. The total market value of equity was obtained for use in regression analysis. Dates of listing and delisting of options were obtained from the statistical department of the Chicago Board Options Exchange. Data related to dividend changes were obtained from the CRSP data bases. Stock price information and equity value were obtained from the Compustat data bases. Dates of earnings announcements were obtained from earnings digest reports in the Wall Street Journal.

The event date used in the event study is the date management announced the dividend change. This is normally the workday preceding the announcement of the dividend change in the Wall Street Journal. The closing price in the month prior to a dividend change was used to calculate the dividend yield. Market value of equity was determined at the end of the year in which the dividend change occurred.

SAMPLE

To test the hypothesis, a sample of optioned firms that experienced significant dividend changes was identified. A second sample consisted of significant dividend changes that occurred in these same firms prior to option listing. For this study, a dividend change of fifteen percent or greater is considered significant.

The original intent in this study was to develop samples of paired dividend changes for each firm. These
pairs would include changes that occurred while options were available and while options were unavailable. The purpose was to enable performance of a paired sample t-test to help determine whether abnormal returns differed between the samples. As data collection progressed, one or more data items were unavailable for one member of many pairs in the sample. The member of the pair for which all data items were available was retained in the sample. There is therefore a high degree of correlation between firms in the optioned and nonoptioned samples, although the mapping is not one to one.

The main results were unaffected by lack of pairing. A paired sample t-test was performed on firms that retained their pairing. This test failed to provide any information not already provided by the two-sample t-test.

In selecting a sample, it was necessary to avoid contaminating dividend announcement effects with earnings announcements effects. As Kane, Lee and Marcus (1984) noted, investors give more credence to unanticipated dividend increases (decreases) when earnings are also above (below) expectations. Dividend announcements were therefore excluded from the sample if they followed a corresponding earnings announcement by less than six days.

Dividend decreases are relatively rare. Investors have been conditioned to associate such decreases with poor management expectations regarding future profitability.
Stock returns around announced decreases are often strongly negative. Managers are therefore understandably reluctant to cut dividends [see Kalay (1980)].

Impson and Karafiath (1992) found statistically significant abnormal returns associated with dividend decreases. Other researchers have noted that the price response to dividend decreases is much more pronounced than that for dividend increases [Eades, Hess, and Kim (1985), Benesh, Keown, and Pinkerton (1984), Charest (1978), and Aharony and Swary (1980)].

The constraint that a firm must have a significant decrease both before and after option listing restricted the size of the dividend decrease sample. Deleting dividend decreases that were preceded by an earnings announcement by less than five days reduced the dividend decrease sample to only three. There was therefore no usable data set for comparing abnormal returns for dividend decreases of optioned versus nonoptioned stocks.

Previous researchers have found a positive relationship between the magnitude of dividend changes and the price response related to those changes. Based on this relationship, the sample for this study has been restricted to dividend changes greater than 15 percent. This restriction should produce more definitive results than would result if smaller changes were included.
The data search involved identifying firms listed on the New York Stock Exchange, the American Stock Exchange, or the NASDAQ that had dividend changes greater than 15% between January 1970 and December 1993. From that sample, firms were selected that had significant changes both before and after option introduction. No firms that had dividend changes while optioned and subsequent to delisting of options remained in the final sample.

Identification of firms with significant dividend increases both before and after option listing led to an initial sample of 228 pairs of dividend changes. Dividend changes that were preceded by an earnings announcement by less than six days were removed from the sample. This filter led to a final sample size of 171 dividend changes for nonoptioned firms and 168 for optioned firms.

The mean and median number of days that a dividend change occurred before or after option listing were determined for the two samples. For the nonoptioned sample, dividend changes were announced a mean (median) of 516 (277) trading days before option listing. For the optioned sample, the mean (median) was 564 (353) trading days after option introduction.

METHODOLOGY

Impson and Karafiath (1992) (IK) analyzed price response to dividend changes. They employed two methods to
examine the stock market reaction to dividend announcements. Dividend announcements were divided into four groups based on whether dividends increased or decreased and whether the payout ratio increased or decreased. A time-series event study was performed to determine whether abnormal returns between each pairing of the four samples differed. In addition, a cross-sectional regression was performed to determine whether the percent change in the dividend and/or the percent change in the payout ratio exhibited explanatory power for abnormal returns associated with the dividend change. A procedure similar to that employed by these two researchers was used in the current study.

Time-series Event Study Procedure:

Two samples were formed based on whether or not options were available on a stock at the time of a significant dividend increase. A standard event study methodology was used to estimate abnormal performance within each sample. Cumulative abnormal returns were estimated for each sample. A Z test was used to determine whether abnormal returns differed significantly between the two groups. The Z test used follows Mikkelson and Partch (1988) as corrected in the December 1988 issue of the Journal of Financial and Quantitative Analysis.
The single index market model (SIMM) parameters were estimated over a 255 day interval ending 46 trading days before the dividend announcement. The SIMM is as follows:

\[ R_{jt} = \alpha_j + \beta_j R_{mt} + \varepsilon_{jt} \]  

(18)

where \( R_{jt} \) is the rate of return of the common stock of the \( j^{th} \) firm on day \( t \); \( R_{mt} \) is the rate of return of a market index on day \( t \); \( \varepsilon_{jt} \) is a random variable that, by construction, must have an expected value of zero, and is assumed to be uncorrelated with \( R_{mt} \), uncorrelated with \( R_{kt,k+j} \), not autocorrelated, and homoschedastic. The parameter \( \beta_j \) measures the sensitivity of \( R_{jt} \) to the market index.

Now define the abnormal return, or prediction error (PE), for the common stock of the \( j^{th} \) firm on day \( t \) as:

\[ PE_{jt} = R_{jt} - (\alpha_j + \hat{\beta}_j R_{mt}) \]  

(19)

where the coefficients \( \alpha_j \) and \( \hat{\beta}_j \) are ordinary least squares estimates of \( \alpha_j \) and \( \beta_j \).

The average abnormal return, or average prediction error (APE) is the sample mean:

\[ APE_t = \frac{\sum_{j=1}^{N} PE_{jt}}{N} \]  

(20)
where \( t \) is defined in trading days relative to the event date (e.g. \( t = -60 \) means 60 trading days before the event).

Over an interval of two or more trading days beginning with day \( T_1 \) and ending with \( T_2 \), the cumulative abnormal prediction error is

\[
\text{CAPE}_{T_1,T_2} = \frac{1}{N} \sum_{j=1}^{N} \sum_{t=T_1}^{T_2} \text{PE}_{jt}
\]

Market adjusted returns are computed by subtracting the observed return on the market index for day \( t \), \( R_m^t \), from the rate of return of the common stock of the \( j^{th} \) firm on day \( t \):

\[
\text{PE}_{jt} = R^t_j - R^t_m
\]

Definitions of average abnormal return and cumulative average abnormal return follow those for market model abnormal returns above.

Comparison period mean adjusted returns are computed by subtracting the arithmetic mean return of the common stock of the \( j^{th} \) firm computed over the estimation period, \( R_j \), from its return on day \( t \):

\[
\text{PE}_{jt} = R^t_j - \bar{R}_j
\]

Definitions of average abnormal return and cumulative average abnormal return follow those for market model abnormal returns above.
In the current study, prediction errors are calculated for each day and each time period in the interval -1 to +1. The event day, day 0, is the date on which management announced a dividend change. To detect a difference between the abnormal returns of two groups of securities, the mean standardized cumulative prediction error (MSCPE) for the group of securities is defined as

\[ MSCPE_i = \sum_{j=1}^{J_i} \frac{SCPE_j}{J_i} \]  

(24)

SCPE\(_j\) is the standardized cumulative prediction error for the \(j\)\(^{th}\) security, and \(J_i\) is the number of securities in the \(i\)\(^{th}\) group. The hypothesis of interest may then be expressed as

\[ H_0: MSCPE_2 - MSCPE_1 = 0 \]  

(25)

To test this hypothesis, a \(Z^*\) statistic was formed such that

\[ Z^* = (MSCPE_2 - MSCPE_1) / \left[ \left( \frac{1}{J_2} \right) + \left( \frac{1}{J_1} \right) \right]^{0.5} \]  

(26)

The \(Z^*\) statistic was used to determine whether the abnormal return of one group of securities differs significantly from those of the other.

Cross-Sectional Regression Procedure:

Independent variables used in the cross-sectional regression include the dummy variable indicating whether
options were available at the time of the dividend change, the percent change in the dividend, the change in dividend yield, and the market value of equity. An interaction term was calculated by multiplying the dummy variable times the natural logarithm of the market value of equity. However, this term was found to contribute no marginal benefit to the regression model. In all cases, the interaction term merely replaced the dummy variable in the final model that resulted from backward elimination. Therefore, the interaction term was eliminated from the model.

For the entire sample, prediction errors or abnormal returns, obtained from the event studies previously performed, were used as the dependent variable in a cross-sectional regression. However, security abnormal returns are heteroschedastic across equations. Ordinary least squares regression would therefore yield an unbiased estimate of the parameter vector but would provide biased estimates of the standard errors (Impson and Karafiath, 1992). Therefore, weighted least squares regression was performed using the inverse of the variance of the abnormal returns as the weight value in the following regression:

\[
CPE_j = \beta_1 \text{DUMMY}_j + \beta_2 \text{DVD}_j + \beta_3 \text{YLD}_j + \beta_4 \text{EQUITY}_j + \varepsilon_j
\]

where

\[CPE_j = \text{cumulative (or daily) prediction error for the } j\text{th firm,}\]
\( DUMMY_j \) = dummy variable coded 0 for nonoptioned and 1 for optioned,
\( DVD_j \) = percent change in the dividend for the \( j \)th firm,
\( YLD_j \) = change in dividend yield for the \( j \)th firm,
and
\( EQUITY_j \) is the natural log of the market value of equity of the \( j \)th firm.

The above regression equation was used to estimate parameters for abnormal returns for each of the four event windows. These windows include intervals \((-1,+1), (0,+1), (-1,0), \) and \((0)\). A backward stepwise procedure was then used to refine the regression equation and determine which of the independent variables were significant. Although use of the backward stepwise procedure in a regression analysis tends to bias parameter estimates on the remaining variables, it does give an indication of the significance of those variables.

Testing Strength of the Dividend Signal:

As noted previously, dividend changes are theorized to be a signal from management regarding expected profitability of the firm. The question being addressed in this essay is whether the existence of traded options on a stock increases the efficiency of stock pricing. If dividend changes are used by management as a signal to the market and optioned stocks are priced more efficiently, managers might perceive
a need to convey a stronger signal to the market for stocks that do not have traded options than for those that do. That is, if existence of an options market decreases information asymmetry, the need to communicate information to the market via dividend signalling may be mitigated. If this is the case, the magnitude of dividend changes may be greater for nonoptioned stocks than for optioned stocks.

To test this possibility, the percentage change in dividends for the optioned sample is compared to that of the nonoptioned sample. Tests used for this comparison include a two-sample t-test, a median test, the Mann-Whitney test, and the Kolmogorov-Smirnov two-sample test.

The two-sample t-test provides a test statistic that indicates whether a difference between means at least equal to the one observed would occur if the two population means are equal. The test statistic is calculated as

\[
t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{S_1^2}{N_1} + \frac{S_2^2}{N_2}}} \tag{28}
\]

where \( \bar{X}_i \) is the sample mean of group \( i \),

\( S_i^2 \) is the variance, and

\( N_i \) is the sample size.
The test statistic used in the median test is

\[ T = \sum_{i=1}^{c} \frac{(O_{1i} - O_{2i})^2}{n_i} \]  

where

\( O_{1i} \) = observations from population \( i \) classified as class 1,
\( O_{2i} \) = observations from population \( i \) classified as class 2,
\( c \) = the number of populations, and
\( n_i \) = the number of observations in population \( i \).

The median test is used to test whether samples come from populations having the same median. The critical region of approximate size \( \alpha \) corresponds to values of \( T \) greater than \( x_{1-\alpha} \), the \((1-\alpha)\) quantile of a chi-square random variable with \( c-1 \) degrees of freedom. If \( T \) exceeds \( x_{1-\alpha} \), reject the hypothesis that all populations have the same median.

The Mann-Whitney test is used to determine whether distribution functions of two samples are equal. Data from both samples are combined into a single ordered sample and ranks are assigned to sample values from smallest to largest. The sum of the ranks assigned to the sample from population \( 1 \) is used to form the test statistic

\[ T = \sum_{i=1}^{n} R(X_i) \]  

(30)
The Kolmogorov-Smirnov two-sample test is also designed to determine whether the distribution functions of two samples are equal. To form the test statistic, let $S_1(x)$ be the empirical distribution function based on the random sample $X_1, X_2, \ldots, X_n$ and let $S_2(x)$ be the empirical distribution function based on the other random sample $Y_1, Y_2, \ldots, Y_m$. The test statistic $T_1$ is then defined as the greatest vertical distance between the two empirical distribution functions:

$$T_1 = \text{MAX} |S_1(x) - S_2(x)|$$

\hspace{1cm} (31)

RESULTS

Time-Series Event Study:

Event study results are presented in Table 1. The table presents a comparison between event study results for optioned versus nonoptioned stocks. For the nonoptioned stocks, the $Z$ statistic indicates statistically significant abnormal returns over all days and intervals tested. Abnormal returns are significant at the 5 percent level for intervals -1 to +1 and 0 to +1 and at the 0.1 percent level for intervals -1 to 0 and on day 0. Abnormal returns for the optioned stocks were not statistically significant for any day or interval tested.

The $Z^*$ statistic was calculated to determine whether there is a difference between abnormal returns for the
optioned and nonoptioned samples. As seen in Table 1, there is a statistically significant difference between abnormal returns for the two samples for interval -1 to 0 (5 percent significance level) and on day 0 (1 percent significance level).

Cross-Sectional Regression Procedure:

Regression parameters were estimated using cumulative prediction error for each interval and for day zero as the dependent variable. As noted previously, independent variables include a dummy variable indicating whether or not the stock was optioned, the percent change in the dividend, the change in dividend yield, and the natural log of the market value of equity. These variables were used in a multiple regression model, followed by a backward stepwise elimination of insignificant variables.

Results of the weighted least squares regression are found in Table 2, Panel A. In this regression, the dummy variable is significant over all windows except -1 to 0. The equity variable is significant over event window 0 to +1 and on the event day. Neither variable related to dividends was significant over any of the event windows.

Results of the backward stepwise procedure are found in Table 2, Panel B. This procedure eliminated both dividend variables over all event windows. The natural log of equity showed statistical significance over all event windows.
Significance is at the five percent level for windows -1 to +1, 0 to +1, and -1 to 0, and is at the one percent level on the event day. The dummy variable was statistically significant over all event windows except days -1 to 0. For event windows -1 to +1 and 0 to +1, significance is at the ten percent level. Significance is at the five percent level on the event day.

Previous researchers have found the percentage change in the dividend to be a significant explanatory variable in a regression such as that performed in this study (e.g., Impson and Karafiath, 1992). Therefore, a weighted least squares regression was performed on the sample used in this study using only the dividend variables. Neither the percentage change in the dividend nor the change in the dividend yield was found to be a significant explanatory variable in this study.

Testing Strength of the Dividend Signal:

A two-sample t-test was used to compare percentage dividend changes between the optioned and nonoptioned samples. Results of this test are found in Table 3, Panel A. This test indicates no significant difference between the means of the two samples.

The nonparametric Mann-Whitney test is more powerful than the two-sample t-test when populations have non-normal distributions. Results of the Mann-Whitney test, seen in
Table 3, Panel B, allow rejection of the null hypothesis that the two samples have the same distribution function (significance level of 10%).

The nonparametric median test is used to determine whether two populations have the same median, regardless of their distribution functions. As seen in Table 3, Panel C, use of the median test indicated that the null hypothesis of equal medians can be rejected at the 1% significance level. For the optioned sample, the dividend change was found to be greater (less) than the median in 71 (97) cases. For the nonoptioned sample, the change was found to be greater (less) than the median in 97 (74) cases.

Results of the Kolmogorov-Smirnov test are in Table 3, Panel D. These results indicate that the two samples have different distribution functions. The null hypothesis of equal distribution functions was rejected at the 10% significance level.

INTERPRETATION

Time-Series Event Study:

Results of event studies support rejection of the null hypothesis. The testable hypothesis is that the price response of optioned stocks to announcement of dividend changes is less pronounced than the price response of nonoptioned stocks. The Z statistic for nonoptioned stocks for intervals -1 to +1, 0 to +1, -1 to 0, and for day 0
indicate statistically significant abnormal returns. The first two event windows show significance at the 5 percent level. The third event window and the event day show significance at the one percent level. None of the Z statistics for the optioned stocks indicated statistically significant abnormal returns for any event window or day tested.

For the interval -1 to 0 and for day 0, the Z' statistic indicates a significant difference between returns on the optioned and nonoptioned samples. For interval -1 to 0, the difference was significant at the 10 percent level. On the event day, the difference was significant at the 5 percent level.

These results indicate that nonoptioned stocks have significantly greater abnormal returns around announced dividend changes than do optioned stocks. This lends support to the hypothesis that optioned stocks are priced more efficiently than nonoptioned stocks. This may result, as is hypothesized, from trading of options by informed traders.

Cross-Sectional Regression Procedure:

Results of a cross-sectional regression indicate that abnormal returns may be influenced by availability of stock options at the time of announced dividend changes. The dummy variable indicating option availability was a
significant explanatory variable for abnormal returns over intervals -1 to +1 and 0 to +1 and on the event day.

Also of interest is the finding that parameter estimates on the percent dividend change and on the change in dividend yield were insignificant for all days and intervals tested. This result prevailed whether dividend variables were used with other variables or used alone. This indicates that the magnitude of the dividend change is unrelated to abnormal returns experienced following an announced dividend change.

The overall implication of these findings is that abnormal returns are related to availability of stock options at the time of announced dividend changes. This indicates that optioned stocks are more efficiently priced than nonoptioned stocks. In conjunction with extant literature in this area, this suggests that use of options by informed traders increases informational efficiency for optioned stocks.

Testing Strength of the Dividend Signal:

Application of the Kolmogorov-Smirnov and Mann-Whitney tests indicated that distribution functions of percentage dividend changes were unequal between optioned and nonoptioned samples. The median test allowed rejection of the null hypothesis of equal medians at the 1% significance level. That is, percentage dividend changes are
significantly larger for nonoptioned stocks than for optioned stocks. If availability of traded options decreases information asymmetry, these findings lend support to the dividend signalling hypothesis. Managers' need to communicate earnings expectations through dividend changes is mitigated by existence of traded options. Dividend changes are therefore smaller for stocks with traded options.

SUMMARY

Overall findings in the study allow rejection of the null hypothesis defined earlier. Thus, we find that abnormal returns of nonoptioned stocks associated with announced dividend changes are greater than abnormal returns of optioned stocks related to such announcements. This result derives particularly from the time-series event study findings. Cross-sectional regression results support the idea that availability of traded options is a useful variable in a regression comparing abnormal returns of optioned and nonoptioned stocks.
### Table 1

Event Study Results

<table>
<thead>
<tr>
<th></th>
<th>Nonoptioned Stocks</th>
<th>Optioned Stocks</th>
<th>Z*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Day or Interval</td>
<td>CPE</td>
<td>Z</td>
</tr>
<tr>
<td></td>
<td>Mean CPE</td>
<td></td>
<td>Mean CPE</td>
</tr>
<tr>
<td>-1 to +1</td>
<td>0.28%</td>
<td>2.01**</td>
<td>0.01%</td>
</tr>
<tr>
<td>0 to +1</td>
<td>0.24%</td>
<td>2.25**</td>
<td>-0.06%</td>
</tr>
<tr>
<td>-1 to 0</td>
<td>0.35%</td>
<td>3.09***</td>
<td>0.07%</td>
</tr>
<tr>
<td>0</td>
<td>0.39%</td>
<td>4.08***</td>
<td>0.04%</td>
</tr>
</tbody>
</table>

J=171 \hspace{2cm} J=168

Note: \( Z^* \) = difference in mean standardized cumulative prediction error
Mean CPE = mean cumulative prediction error

* Significant at the 10 percent level
** Significant at the 5 percent level
*** Significant at the 1 percent level
Table 2
Cross-Sectional Regression Results

Panel A

t-tests for Independent Variables

<table>
<thead>
<tr>
<th>Interval</th>
<th>Dummy/ t-test</th>
<th>Equity/ t-test</th>
<th>Divchng/ t-test</th>
<th>Yldchng/ t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1 to +1</td>
<td>-0.575</td>
<td>0.029</td>
<td>0.045</td>
<td>-0.262</td>
</tr>
<tr>
<td></td>
<td>-1.931*</td>
<td>1.621</td>
<td>0.047</td>
<td>-0.404</td>
</tr>
<tr>
<td>0 to +1</td>
<td>-0.457</td>
<td>0.026</td>
<td>0.052</td>
<td>-0.223</td>
</tr>
<tr>
<td></td>
<td>-1.852*</td>
<td>1.78*</td>
<td>0.068</td>
<td>-0.439</td>
</tr>
<tr>
<td>-1 to 0</td>
<td>-0.341</td>
<td>0.010</td>
<td>0.575</td>
<td>0.011</td>
</tr>
<tr>
<td></td>
<td>-1.395</td>
<td>0.794</td>
<td>0.707</td>
<td>0.020</td>
</tr>
<tr>
<td>0</td>
<td>-0.402</td>
<td>0.021</td>
<td>0.047</td>
<td>0.076</td>
</tr>
<tr>
<td></td>
<td>-2.21**</td>
<td>2.504**</td>
<td>0.120</td>
<td>0.203</td>
</tr>
</tbody>
</table>

* Significant at the 10 percent level
** Significant at the 5 percent level
*** Significant at the 1 percent level

Panel B
Results of Backward Elimination

<table>
<thead>
<tr>
<th>Interval</th>
<th>Dummy/ t-test</th>
<th>Equity/ t-test</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1 to +1</td>
<td>-0.554</td>
<td>0.028</td>
</tr>
<tr>
<td></td>
<td>-1.95*</td>
<td>2.37**</td>
</tr>
<tr>
<td>0 to +1</td>
<td>-0.452</td>
<td>0.024</td>
</tr>
<tr>
<td></td>
<td>-1.84*</td>
<td>2.60**</td>
</tr>
<tr>
<td>-1 to 0</td>
<td>0.012</td>
<td>2.04**</td>
</tr>
<tr>
<td>0</td>
<td>-0.399</td>
<td>0.023</td>
</tr>
<tr>
<td></td>
<td>-2.24**</td>
<td>3.69***</td>
</tr>
</tbody>
</table>

* Significant at the 10 percent level
** Significant at the 5 percent level
*** Significant at the 1 percent level
Table 3
Inter-Group Comparison of Percentage Change in Dividends
Nonparametric Test Results

<table>
<thead>
<tr>
<th>2-Sample T-test T-Value</th>
<th>Median Test Chi-Square</th>
<th>Mann-Whitney Z-value</th>
<th>Kolmogorov-Smirnov Z-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>-1.03</td>
<td>6.5246***</td>
<td>-1.892*</td>
<td>1.337*</td>
</tr>
</tbody>
</table>

* Significant at the 10% level
** Significant at the 5% level
*** Significant at the 1% level
REFERENCE WORKS


Fedenia, Mark and Theoharry Grammatikos (1992), "Options Trading and the Bid-Ask Spread of the Underlying Stocks," *Journal of Business* 65, 335-351.


