BEBR

FACULTY WORKING
PAPER NO. 746

The Impacts of Options' Expiration, Unanticipated Inflation, Errors in Forecasted Earnings, and Trading Volume on Daily Market Returns

David T. Whitford
Frank K. Reilly

College of Commerce and Business Administration
Bureau of Economic and Business Research
University of Illinois, Urbana-Champaign

BEBR

FACULTY WORKING PAPER NO. 746

College of Commerce and Business Administration

University of Illinois at Urbana-Champaign

February 1981

The Impacts of Options' Expiration, Unanticipated Inflation, Errors in Forecasted Earnings, and Trading Volume on Daily Market Returns

David T. Whitford, Assistant Professor
Department of Finance

Frank K. Reilly, Professor
Department of Finance

Acknowledgment: The authors are indebted to Ms. Ellen B. Kossar and Mr. Chen-Chin Chu for assistance in data collection and statistical analysis. The comments and suggestions of Professors Kenneth J. Carey, Paul Newbold, and the participants in the Finance Workshop at the U of I were also helpful. Finally, the financial and computational support provided by the Research Board and Computer Services Office of the University of Illinois at Urbana-Champaign are also gratefully acknowledged.

Abstract

This research focuses upon the impacts that the expiration of option contracts, errors in forecasts for earnings and inflation, and trading volume had upon daily changes in the Dow Jones Industrial Average (DJIA) during 1978. The results indicate that, *ceteris paribus*, the expiration of option contracts depresses changes in the DJIA. Statistical evidence consistently confirmed the dramatic effect of unanticipated inflation on stock prices. Finally, a surprisingly strong degree of market efficiency was detected. It appears that by the time earnings announcements appear in the *Wall Street Journal*, it is too late to react to this "new" information.

The Impacts of Options' Expiration, Unanticipated Inflation, Errors in Forecasted Earnings, and Trading Volume on Daily Market Returns*

During the last several years, a number of institutional changes and economic events have affected the structure and performance of U.S. equity markets. However, two factors, inflation and options trading, have had a striking impact upon the market. The accelerating rate of inflation has caused many investors to question whether increases in corporate earnings and cash flow can offset the erosion of real corporate purchasing power and dividends. Since the initiation of the trading of listed call options on the Chicago Board Options Exchange (CBOE) in April 1973, investor interest in options and option trading volume has surged. For example on several days during 1978, the stock trading volume represented by option contracts for the 221 stocks listed on the five[1] options exchanges exceeded the actual share volume in all New York Stock Exchange listed stocks for the days.[2]

Theoretical developments in option pricing have closely paralleled the growing popularity of these financial instruments. Professors Black and Scholes, Merton, Parkinson, and Cox and Ross have developed general

---

[1]The CBOE and Midwest Stock Exchange merged their options as of June 2, 1980.

[2]See Margaret D. Pacey, "The Striking Price," Barron's, Dow Jones & Co., Vol. LIX, No. 1 (January 1, 1979), p. 37.

equilibrium models for the option pricing problems.[3] In addition, several others have investigated either the efficiency of the U.S. options market[4] or examined alternative option writing strategies that one might follow in order to reduce risk and/or increase return.[5] Finally, several studies have analyzed the impact that option contracts have upon

---

[3]See for example Fisher Black and Myron Scholes, "The Pricing of Options and Corporate Liabilities," Journal of Political Economy, Vol. 81, No. 3 (May/June 1973), pp. 637-654; Robert Merton, "Theory of Rational Option Pricing," Bell Journal of Economics and Management Science, Vol. 4, No. 1 (Spring 1973), pp. 141-183; Michael Parkinson, "Options Pricing: The American Put," Journal of Business, Vol. 50, No. 1 (January 1977), pp. 21-36; and John C. Cox and Stephen A. Ross, "The Valuation of Options for Alternative Stochastic Processes," Journal of Financial Economics, Vol. 3, No. 1/2 (January-March 1976), pp. 145-166.

[4]See for example Joseph E. Finnerty, "The Chicago Board Options Exchange and Market Efficiency," Journal of Financial and Quantitative Analysis, Vol. 8, No. 1 (March 1978), pp. 29-38; Robert C. Klemkosky, "The Impact of Option Expiration on Stock Prices," Journal of Financial and Quantitative Analysis, Vol. 13, No. 3 (September 1978), pp. 507-518; Dan Galai, "Test of Market Efficiency of the Chicago Board Options Exchange," Journal of Business, Vol. 50, No. 2 (April 1977), pp. 167-197; and James D. MacBeth and Larry J. Merville, "An Empirical Examination of the Black Scholes Call Option Pricing Model," Journal of Finance, Vol. 34, No. 5 (December 1979), pp. 1173-1186.

[5]See Michael J. Gambola, Rodney L. Roenfeldt, and Philip L. Cooley, "Spreading Strategies on CBOE Options: Evidence on Market Performance," Journal of Financial Research, Vol. 1, No. 1 (Winter 1978), pp. 33-44; Gary L. Gastineau, The Stock Options Manual, 2nd Edition (New York: McGraw-Hill, 1979); and Burton G. Malkiel and Richard E. Quandt, Strategies and Rational Decisions in the Securities Option Market (Cambridge, Mass.: The MIT Press, 1969), for a limited sample.

the volatility and returns of individual securities.[6] Unfortunately none of these studies focused upon the simultaneous interactions and effects that options trading, inflation, and earnings announcements have had upon the stock market. This study measures these interactions and examines the impact of these factors during 1978 on daily price changes of a widely used stock market indicator series. The measure of stock market performance is a portfolio of thirty securities that comprise the Dow-Jones Industrial Average (DJIA).

The study is composed of five sections. Section I provides a brief background on the "Dow 30", and the characteristics of the option contracts for these stocks. Section II develops the hypotheses to be tested, and section III contains a description of the statistical procedures used to obtain estimates for "market" expectations. Section IV contains results of the study, and the final section provides a summary and discusses the implications of the research.

---

[6]Robert R. Nathan Associations, Inc., Review of Initial Trading Experiences at the Chicago Board Options Exchange, prepared for the CBOE, (December 1974), Chapter 2, and Sidney M. Robbins, Robert B. Stobaugh, Francis L. Sterling, and Thomas H. Howe, "The Impact of Exchange-Traded Options on the Market for New Issues of Common Stock of Small Companies," The Financial Review (Winter 1979), pp. 1-22; and Samuel L. Hayes, III and Michael E. Tennenbaum, "The Impact of Listed Options on the Underlying Shares," Financial Management, Vol. 8, No. 4 (Winter 1979), pp. 72-76. For an alternative view see Robert Lenzher, "Call of the Wild: Options--Despite Denials--Influence Movements in Stocks," Barron's (May 3, 1976), p. 5.

I. The DJIA and Option Contracts

Although there are better indices of stock market performance, breadth, depth, and resiliency,[7] no series is as widely quoted or recognized as the DJIA. The companies that comprised the DJIA during 1978 are given in Table 1. The corporations in the index are generally among the largest and most prestigious firms in their respective industries.

As shown in Table 1, twenty-five of the "Dow 30" had call options traded on various exchanges during 1978. Indeed, twenty of the corporations had options that expired on the Saturday following the third Friday of each January, April, July, and October. Four companies had contracts that expired in February, May, August, and November; and one corporation had a listed option with a March, June, September, and December expiration series. An analysis of all 221 listed option contracts traded in December, 1978 indicates that most options expire in the Jan-Apr-July-Oct schema.

Although capital market theory developed by Lintner and Sharpe[8] indicates that investors should hold portfolios comprised of market weighted proportions of all types of investments, most empirical tests

---

[7] See Jack C. Francis, Investments Analysis and Management, 3rd edition (New York: McGraw-Hill, 1980), pp. 142-147, for a critique of the DJIA's shortcomings and the characteristics desirable in a market index.

[8] John Lintner, "The Valuation of Risk Assets and the Selection of Risky Investment in Stock Portfolio and Capital Budgets," Review of Economics and Statistics, Vol. 47, No. 1 (February 1965), pp. 13-37 and William Sharpe, "Capital Asset Prices: A Theory of Market Equilibrium Under Conditions of Risk," Journal of Finance, Vol. 19, No. 31 (September 1964), pp. 425-442.

Table 1

Description of Listed Option Contracts for the 30 Stocks in the DJIA Dow-Jones Thirty Industrials - 1978*

Corporations****	Options Traded Put	Options Traded Call	Exchange Listing(s)	1978 Monthly Expirations
ied Chemical	no	yes	Philadelphia Exchange	Jan-Apr-Jul-Oct
oa	no	yes	Chicago Board	Jan-Apr-Jul-Oct
rican Brands	no	no	n/a	n/a
rican Can	no	no	n/a	n/a
T	no	yes	Chicago Board	Jan-Apr-Jul-Oct
hlehem Steel	no	yes	Chicago Board	Jan-Apr-Jul-Oct
ysler	no	no	n/a	n/a
ont	no	yes	Chicago Board	Jan-Apr-Jul-Oct
	no	yes	American Stock Exchange	Jan-Apr-Jul-Oct
tman Kodak	yes	yes	Chicago Board	Jan-Apr-Jul-Oct
ark**	no	no	n/a	n/a
on	no	yes	Chicago Board	Jan-Apr-Jul-Oct
eral Electric	no	yes	Chicago Board	Jan-Apr-Jul-Oct***
eral Foods	no	yes	Chicago Board	Feb-May-Aug-Nov
eral Motors	yes	yes	Chicago Board	Jan-Apr-Jul-Oct***
dyear	no	yes	American Stock Exchange	Jan-Apr-Jul-Oct
O**	no	no	n/a	n/a
ernational Harvester	no	yes	Chicago Board	Jan-Apr-Jul-Oct
ernational Paper	no	yes	Chicago Board	Jan-Apr-Jul-Oct
ns-Manville	no	yes	Chicago Board	Feb-May-Aug-Nov
	no	yes	Chicago Board	Jan-Apr-Jul-Oct
ns-Illinois	no	yes	Midwest Exchange	Mar-Jun-Sep-Dec
cter & Gamble	no	yes	American Stock Exchange	Jan-Apr-Jul-Oct
rs & Roebuck	no	yes	Chicago Board	Jan-Apr-Jul-Oct***
ndard Oil of California	no	yes	American Stock Exchange	Jan-Apr-Jul-Oct***
aco	no	yes	American Stock Exchange	Jan-Apr-Jul-Oct
on Carbide	no	yes	American Stock Exchange	Jan-Apr-Jul-Oct
ted Technologies	no	yes	Chicago Board	Feb-May-Aug-Nov
. Steel	no	yes	American Stock Exchange	Jan-Apr-Jul-Oct
tinghouse	yes	yes	American Stock Exchange	Jan-Apr-Jul-Oct
lworth	no	yes	Philadelphia Exchange	Feb-May-Aug-Nov

late June 1979 Chrysler and Esmark were replaced by International Business Machines
. and Merck & Co. At that time puts and calls on IBM and calls on Merck were
led on the Chicago Board for the Jan-Apr-Jul-Oct series.

mark was formerly Swift and Company; INCO was International Nickel.

n 1979 General Motors, General Electric, Standard Oil of California, and Sears
racts expired in January, April, June, September and December.

*The majority of these corporations have fiscal quarters that end in March, June,
ember, and December. However, the fiscal quarters for Esmark, International
ester, Sears, and Woolworth end in January, April, July, and October. AT&T's
al quarters end in February, May, August, and November.

ce: Wall Street Journal and Barron's various issues, Dow-Jones & Company.

of their theory are restricted to the universe of common stocks. Based upon the popularity of the DJIA as an index of stock market performance, one can view the DJIA as a proxy "market" portfolio, although it is unwarranted to refer to the DJIA as the market portfolio because of the index's composition. Indeed the composition of various market indices has raised interesting questions concerning the testability of the Sharpe-Lintner capital asset pricing model (CAPM) and financial economists' ability to adequately identify the market portfolio.[9]

Nevertheless, James Lorie and Mary Hamilton[10] have shown that correlation coefficients between monthly closing values for the DJIA and several widely used surrogates for the market are quite high. More recent work by Reilly[11] using daily percent price changes indicates that these correlations persisted in the 1970's.

Although one cannot confidently classify the DJIA as the market portfolio, it does closely parallel broadly diversified portfolios designed to capture stock market trends. Therefore, we can ascertain

---

[9] See Richard Roll, "A Critique of the Asset Pricing Theory's Tests, Part I: On Past and Potential Testability of the Theory," Journal of Financial Economics, Vol. 4, No. 2 (March 1977), pp. 129-176, and _____________, "Ambiguity When Performance is Measured by the Securities Market Line," Journal of Finance, Vol. 33, No. 4 (September 1978), pp. 1051-1069.

[10] James H. Lorie and Mary T. Hamilton, "Stock Market Indexes," in James Lorie and Richard Brealey (eds.), Modern Developments in Investment Management, 2nd ed. (Hinsdale, Ill.: Dryden Press, 1978), pp. 78-93.

[11] Frank K. Reilly, Investment Analysis and Portfolio Management (Hinsdale, Illinois: The Dryden Press, 1979), pp. 130-131.

the "systematic" impact, if any, that option expirations might have upon daily stock price changes for this market proxy portfolio.

An analysis of daily closing prices during 1978 indicated that the DJIA closed on Tuesday, January 3, 1978 at 817.74, reached a low closing price of 742.12 on February 28th, a high closing price of 907.74 on September 8th and 11th, and finished the year at 805.01 just 12.73 points below its initial value. An examination of daily trading volume for the stocks in the DJIA during 1978 shows four significant high and low spikes. These spikes occur on or near the Jan-Apr-Jul-Oct option expiration dates.[12] Finally, the analysis of daily price changes for the DJIA during 1978 indicates similar patterns in the timing of the spikes and option expiration dates but these relationships are not highly correlated. Nevertheless, there appears to be some relationship between option expiration, daily volume, and daily price changes for the DJIA that justifies further analysis.

II. Factors Influencing Stock Price Changes

Eugene Fama (1976, p. 143)[13] has characterized an efficient capital market as follows:

---

[12] Since 1976, expiration dates for all listed options contracts fall on the Saturday following third Friday of each contract expiration month. However, actual trading of contracts ceases on Friday afternoon. During 1978 these expiration Fridays were Jan. 20th, Feb. 17th, Mar. 17th, Apr. 21st, May 19th, Jun. 16th, Jul. 21st, Aug. 18th, Sep. 15th, Oct. 20th, Nov. 17th, and Dec. 15th.

[13] Eugene F. Fama, "Reply to LeRoy," Journal of Finance, Vol. 31, No. 1 (March 1976), pp. 143-145.

Market efficiency requires that in setting the prices of securities at any time, t-1, the market correctly uses all available information ... formally, in an efficient market

$$f(P_t|\phi_{t-1}) = f_m(P_t|\phi^m_{t-1}), \tag{1}$$

where $P_t = (p_{1t},\ldots,p_{nt})$ is a vector of prices of securities at time t, ϕ_{t-1} is a set of information available at t-1, ϕ^m_{t-1} is the set of information used by the market, $f_m(P_t|\phi^m_{t-1})$ is the market assessed density function for P_t, and $f(P_t|\phi_{t-1})$ is the true density function implied by ϕ_{t-1}.

In terms of the Sharpe-Lintner[14] capital asset pricing model, the expected return of the jth security from time t to t+1 can be described as:

$$E(\tilde{r}_{j,t+1}|\phi_t) = r^*_{t+1} + \frac{E(\tilde{r}_{m,t+1}|\phi_t)-r^*_{t+1}}{\sigma(\tilde{r}_{m,t+1}|\phi_t)} \times \frac{cov(\tilde{r}_{j,t+1},\tilde{r}_{m,t+1}|\phi_t)}{\sigma(\tilde{r}_{m,t+1}|\phi_t)} \ . \tag{2}$$

In equation (2) r^*_{t+1} is the return from t to t+1 on the riskless asset;[15] E is the expectations operator, $\tilde{r}_{m,t+1}$ is the return on the

---

[14] John Lintner, "The Valuation of Risk Assets," op. cit. and William Sharpe, "Capital Asset Prices," op. cit.

[15] Subsequent research by Black, Jensen, and Scholes as well as Black has demonstrated that equation (2) may be inappropriate. Instead they hypothesize a zero-beta factor $E(\tilde{r}^z)$ in place of the risk-free rate, where $E(\tilde{r}^z_{t+1}|\phi_t)$ is the expected return on a risky portfolio, given ϕ_t, that is uncorrelated with the market return. See Fisher Black, Michael C. Jensen, and Myron Scholes, "The Capital Asset Pricing Model: Some Empirical Tests," in Michael C. Jensen, ed., Studies in the Theory of Capital Markets (New York: Praeger Publishers, 1972), pp. 79-121 and Fisher Black, "Capital Market Equilibrium with Restricted Borrowing," Journal of Business, Vol. 45, No. 3 (July 1972), pp. 444-454.

"market portfolio," $\sigma(\tilde{r}_{m,t+1}|\phi_t)$ and $\text{cov}(\tilde{r}_{j,t+1},\tilde{r}_{m,t+1}|\phi_t)$ are respectively the standard deviation of the market portfolio's return and the covariance between the returns of the jth security and the market portfolio; and the tildes denote random variables. The appearance of the ϕ_t terms indicates that the appropriate elements of equation (2) depend upon a given information set. Although the reality of the model has been criticized, it has been shown that most of the assumptions of the CAPM can be relaxed without loss of generality.[16]

The principal hypothesis of this study focuses upon the process contained in equations (1) and (2). Many factors enter into the ϕ_t information set used by investors to make financial decisions. However, one would not expect a major disequilibrium to occur unless the new information was at variance with widely held beliefs or more precisely, the beliefs that established the most recent price and hence return.

In an attempt to explain average daily price changes for the DJIA, this study focuses upon four factors: (1) proximity to option contract expiration dates, (2) unexpected changes in earnings, (3) unexpected changes in inflation and (4) trading volume. Each of these factors will be discussed below.

<u>Options Contract Expiration</u>

As Klemkosky[17] has pointed out, a case can be made for the existence of downward pressure on the price of an underlying common stock

---

[16] Michael C. Jensen, "Capital Markets: Theory and Evidence," <u>Bell Journal of Economics and Management Science</u>, Vol. 3, No. 2 (Autumn 1972), pp. 357-398.

[17] Robert C. Klemkosky, "The Impact of Option Expirations," <u>op. cit.</u>, pp. 508-510.

during the week prior to option expiration. Subsequently, during the week after expiration, one would expect corrections back toward equilibrium prices. These downward pressures can be caused by several factors. First, call option buyers generally present most exercise or tender notices during the final week of trading and after they receive their shares, they in turn sell them. A sudden influx of call buyers "dumping" their shares during the final week of the contract could create downward selling pressure. Second, option prices can have a large time premium depending upon the time remaining on the contract's life. This time premium approaches zero as the contract approaches its expiration date. If an option is "out of the money" (i.e., the price of the underlying stock is less than the option's exercise or striking price) as expiration approaches, the option will expire essentially worthless. If the seller or writer of a call has created a "variable hedge" by acquiring the underlying stock, the writer of the call might sell his/her hedged equity position during the last week because of the small probability of a forthcoming exercise notice. Again such a sale of the underlying stock could create downward pressure on stock prices. Third, price declines can be generated when "in the money" (i.e., the underlying stock price is above the striking price) writers attempt to close out their positions during the expiration week. If a hedged writer were to simultaneously buy back his/her option contract when time premiums were lowest and sell the underlying "hedged shares," there would be downward price pressure in the stock market. However, offsetting upward pressure in the options market might neutralize this effect.

Using a mean residual technique first suggested by Fama et al.,[18] Klemkosky found support for his downward disequilibrium and correcting hypothesis for the Jan-Apr-Jul-Oct and Aug-Nov-Feb-May expiration scheme during 1975 and 1976. In contrast to Klemkosky's results, it is possible to argue that option expirations could cause significant upward price and trading volume pressure before and after expiration dates. For example if one assumes that a group of speculators have written a series of "naked" calls,[19] there could be a potential "short squeeze" if there was a sudden and unanticipated acceleration in prices. In order to prevent extraordinary losses, the "naked writers" must acquire underlying shares or buy back their contracts. Thus there could be significant upward price and volume momentum, and equilibrium prices might not be reached for several trading days. The length of this disequilibrium period would be a function of the degree of unanticipated forecast error, and the ability of individuals to adjust their expectations to new, unexpected events. How much this short squeeze might feed upon itself is difficult to predict. However, because of the significant risks involved in writing naked calls, it is doubtful that

---

[18] Eugene F. Fama, Lawrence Fisher, Michael C. Jensen, and Richard Roll, "The Adjustment of Stock Prices to New Information," International Economic Review, Vol. 10, No. 1 (February 1969), pp. 1-21.

[19] A "naked" option implies that the writer does not have an ownership position in the option's underlying common stock. Thus in the event of an unexpected price rise, the call writer must acquire either the stock or repurchase the option, thereby creating significant upward price pressure. Most brokerage firms require at least $10,000 on deposit in brokerage house accounts in order to be eligible to write "naked" calls.

they could provide overwhelming momentum. Still, options specialists and market makers who operate continuously in the market might cause this type of short squeeze.

The previous discussion indicated that momentum could be generated by a sudden and unexpected acceleration in stock prices. Further, this momentum could be amplified if stock price inertia pushed a significant number of options "into the money." The data in Table 2 provide insight into this momentum or acceleration phenomenon. Specifically, Table 2 contains the open interest (i.e., number of contracts outstanding) and the relative changes in "in the money" - "out of the money" classifications for all call contracts outstanding on the twenty-five DJIA corporations with listed options. The number of outstanding contracts are taken three weeks and one week prior to expiration. Two interesting trends are apparent in the total open interest values during 1978. First, the total number of options outstanding tends to increase during January, April, July, and October. Of course these are the contract expiration months for twenty of the twenty-five DJIA components with listed options. Second, there were more contracts outstanding one week prior to the 1978 monthly expiration dates than were in effect two weeks earlier. A means test was performed to determine if there was a statistically significant difference between the average total option open interest one and three weeks prior to the January, April, July and October expiration dates and the remaining average outstanding open interest figures. The results of this test indicated the null hypothesis of equal means can be rejected at the .025 level. This implies support for the alternative hypothesis that

TABLE 2

Outstanding Call Option Contract Volume for the DJIA - 1978*

78 ntract Expiration tes	Outstanding Option Contract Open Interest: # Weeks Prior to Expiration	Date	"In the Money" #	"In the Money" % of Total	"Out of the Money" #	"Out of the Money" % of Total	Total
nuary 20th	3	12/30	134,971	28.3	341,058	71.7	476,209
	1	1/13	48,888	10.3	426,531	89.7	475,419
bruary 17th	3	1/27	35,664	10.6	301,941	89.4	337,605
	1	2/10	63,132	17.5	297,125	82.5	360,257
rch 17th	3	2/24	52,062	13.5	334,095	86.5	386,157
	1	3/10	62,377	14.9	356,625	85.1	419,002
ril 21st	3	3/31	89,660	19.5	369,977	80.5	459,637
	1	4/14	160,300	35.2	294,526	64.8	454,826
y 19th	3	4/28	205,504	58.4	146,310	41.6	351,814
	1	5/12	178,434	43.7	230,135	56.3	408,569
ne 16th	3	5/26	117,867	26.2	332,550	73.8	450,417
	1	6/9	191,307	39.2	296,469	60.8	487,776
ly 21st	3	6/30	126,452	23.3	417,243	76.7	543,695
	1	7/14	185,002	32.5	383,892	67.5	568,894
gust 18th	3	7/28	169,943	38.3	273,960	61.7	443,903
	1	8/11	226,961	44.0	289,427	56.0	516,388
ptember 15th	3	8/25	177,413	31.9	378,827	68.1	556,240
	1	9/8	198,640	33.9	386,940	66.1	585,580
tober 20th	3	9/29	167,952	28.9	413,393	71.1	581,345
	1	10/13	216,156	34.1	417,144	65.9	633,300
vember 17th	3	10/27	49,632	11.6	379,786	88.4	429,418
	1	11/10	59,932	12.7	412,314	87.3	472,246
cember 15th	3	11/24	97,614	20.7	374,383	79.3	471,997
	1	12/8	90,187	18.0	411,232	82.0	501,419

*Source, Barron's, Dow-Jones, Inc. various issues.

there was a significant increase in the number of options on the DJIA components during 1978 for the period around contract expiration dates. Also a means test was performed to determine if there was a statistical difference between the number of contracts outstanding one and three weeks prior to the monthly expiration dates during 1978. The results indicated that one cannot reject the null hypothesis that the number of contracts outstanding on the DJIA components one and three weeks prior to the 1978 option expiration dates are equal.

Clearly something was at work prior to the DJIA option expiration dates in 1978. The question remains whether these forces could create upward market price and volume momentum.

Unexpected Changes in Earnings

Numerous prior studies have tested the joint hypothesis[20] that the market is efficient and that asset returns are generated by some form of the CAPM (equation 2). These studies[21] generally concluded that statistically significant and positive risk adjusted returns are observed after earnings announcements. The accumulated evidence of these studies provides strong evidence that (1) the efficient market process as described by equation (1) may not adequately describe reality at least in the short-run; (2) the inefficiency implied is not substantial and abnormal risk-adjusted returns will probably be negated

---

[20] See Eugene Fama, "Reply to LeRoy," op. cit., pp. 143.

[21] For an enlightening review see Ray Ball, "Anomalies in Relationships Between Securities' Yield and Yield Surrogates," Journal of Financial Economics, Vol. 6, No. 23 (June/September 1978), pp. 103-126.

by transactions costs; and (3) deficiencies in the CAPM return generating process do not explain abnormal returns.[22]

Because this study focuses upon the daily price change characteristics of a market portfolio proxy, there is no adjustment for risk. By definition, if the DJIA is a market surrogate, it cannot provide abnormal returns. Clearly this does not imply that earnings announcements made by the individual corporations in the DJIA will have no effect upon the index. On the contrary, unless controls are established to account for the timing of earnings' announcements and the magnitude of forecast errors, significant bias will result.

Table 3 contains a detailed summary of the publication dates for quarterly earnings for companies in the DJIA made during 1978. It is hypothesized that these announcements could have had a significant impact upon investor expectations, if the earnings were at variance with expectations.[23] Notably, many of these publication dates are clustered around the January 20th, April 21st, July 21st, and October 20th option trading expiration dates in 1978. Thus there may

---

[22]Ross L. Watts, "Systematic 'Abnormal' Returns After Quarterly Earnings Announcements," Journal of Financial Economics, Vol. 6, No. 23 (June/September 1978), pp. 127-150.

[23]James M. Patell and Mark A. Wolfson, "Anticipated Information Releases in Call Option Prices," Journal of Accounting and Economics, Vol. 1, No. 2 (August 1979), and ________ and ________, "Preliminary Evidence of the Effect of Quarterly Earnings and Dividend Announcements on Call Option Prices," Working Paper, Graduate School of Business, Stanford University (March 1979), provides strong evidence that implied standard deviations imbedded within option prices typically increases prior to earnings announcements and decline thereafter.

TABLE 3

Quarterly Earnings Publication Dates Dow Jones* Industrial Average - 1978

4th Quarter - 77		1st Quarter - 78		2nd Quarter - 78		3rd Quarter - 78	
Date	Company	Date	Company	Date	Company	Date	Company
12/20(77)	AT&T	3/16	AT&T	6/21	AT&T	9/28	AT&T
1/18	Int. Paper	4/11	G.E.	7/13	G.E.	10/12	G.E.
1/20	Alcoa	4/12	Int. Paper		Int. Paper		Int. Paper
	Allied Chem.	4/13	Westinghouse	7/14	O-I		Kodak
	Westinghouse		O-I	7/17	Allied Chem.		O-I
1/24	DuPont	4/14	Allied Chem.		Westinghouse		Westinghouse
	3-M	4/18	DuPont	7/18	United Chem.	10/16	Allied Chem.
1/25	Exxon	4/20	Amer. Can	7/20	DuPont	10/17	United Tech.
1/26	Beth. Steel		INCO		Kodak	10/19	DuPont
	G.F.	4/21	Alcoa	7/21	Amer. Can		Johns-Man.
	Std. Oil CA		3-M	7/24	Alcoa	10/20	Alcoa
1/27	G.E.		Amer. Brands		Amer. Brands		Amer. Can
	Union Carb.		Johns-Man.		INCO		INCO
1/28	Texaco	4/24	Kodak		Union Carb.		3-M
1/31	P&G		Union Carb.	7/25	Exxon	10/23	Union Carb.
	United Tech.	4/25	Exxon	7/26	Goodyear	10/24	Exxon
2/1	Amer. Can		Goodyear		3-M	10/26	Beth. Steel
	U.S. Steel	4/26	Beth. Steel		U.S. Steel		Goodyear
2/3	Amer. Brands		G.F.	7/27	Beth. Steel		Amer. Brands
2/6	O-I		GM		Johns-Man.		G.F.
2/7	INCO		P&G	7/28	G.F.	10/27	Texaco
2/8	GM		United Tech.		GM		P&G
	Johns Man.		U.S. Steel		Std. Oil CA		Std. Oil CA
2/10	Kodak	4/27	Chrysler	7/31	Chrysler	10/30	GM
2/15	Goodyear		Std. Oil CA		Texaco	11/1	U.S. Steel
2/16	Int. Harv.		Texaco	8/11	P&G	11/3	Chrysler
2/24	Chrysler	5/18	Int. Harv.	8/21	Int. Harv.	11/20	Woolworth
	Esmark	5/19	Woolworth		Woolworth	11/22	Sears
3/9	Woolworth	5/26	Sears	8/23	Sears	12/8	Int. Harv.
3/22	Sears	5/30	Esmark	8/23	Esmark	12/11	Esmark

*Source: Various issues of the Wall Street Journal (Dow-Jones and Co.)

be a contemporaneous interaction between option expiration and earnings announcements effects.

Unexpected Changes in the Rate of Inflation

The previous discussion of market efficiency placed strong emphasis upon expectations and unanticipated departures from forecasts. In a pathbreaking work on the development of a theory of the term structure of interest rates, David Meiselman[24] provided strong evidence that an "error-learning" mechanism is a dominant factor in investors revision of interest rate expectations.

The option pricing procedure developed by Black and Scholes[25] shows that a key determinant of equilibrium involves the creation of a riskless hedge, which will earn the risk-free rate of interest. In addition, Merton[26] has shown that option values will increase as this riskless rate increases. As a result, unexpected increases in the risk-free rate will, *ceteris paribus*, generate unexpected increases in option prices, and hence upward price and volume pressure.

Notably, unexpected increases in the riskless rate could also generate *downward* price pressure on underlying stock prices. In this

---

[24] David Meiselman, *The Term Structure of Interest Rates*, (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1962).

[25] Fisher Black and Myron Scholes, "The Pricing of Options," *op. cit.*

[26] Robert Merton, "The Theory of Rational Option Pricing," *op. cit.*

regard, Fama (1975, 1977)[27] has demonstrated that short-term interest rates accurately mirrored expected rates of inflation during the period 1953-1971. His results tend to confirm Fisher's[28] view that the nominal rate of interest represents some expected real return plus an assessment of the expected rate of inflation.

Similarly, John Lintner[29] contends that equity prices will decline during transition periods in which actual inflation rates are higher than expected rates. In contrast, during transition periods when actual rates of inflation are below expected rates, unusually large capital gains will occur. This logic explains the persistent trend for both nominal and real returns on equity securities to be negatively and significantly related to inflation rates. Convincing support for Lintner's thesis is given by numerous studies.[30] They show that although equity securities have often been touted as a major hedge against inflation, actual equity returns during periods of high inflation were rather perverse as inflation hedges.

---

[27]Eugene F. Fama, "Short-Term Interest Rates as Predictors of Inflation," American Economic Review, Vol. 65, No. 3 (June 1975), pp. 269-282 and ____________, "Interest Rates and Inflation: The Message in the Entrails," American Economic Review, Vol. 67, No. 3 (June 1977), pp. 487-496.

[28]Irving Fisher, The Theory of Interest (New York: MacMillan and Co., 1930).

[29]John Lintner, "Inflation and Security Returns," Journal of Finance, Vol. 30, No. 2 (May 1975), pp. 259-280.

[30]In this regard, see Eugene F. Fama and G. William Schwert, "Asset Returns and Inflation," Journal of Financial Economics, Vol. 5, No. 2 (November 1977), pp. 115-146; Frank K. Reilly, Glenn L. Johnson, and Ralph E. Smith, "Inflation, Inflation Hedges and Common Stock," Financial Analysts Journal, Vol. 26, No. 1 (January-February, 1970), pp. 104-110; F. K. Reilly, R. E. Smith, and G. L. Johnson, "A Correction and Update Regarding Individual Stocks As Inflation Hedges," Journal of Financial and Quantitative Analysis, Vol. 8, No. 2 (March, 1973), pp. 247-258.

The foregoing analysis yields some rather curious conclusions. First, unanticipated increases in inflation will create upward pressure on interest rates and therefore option prices, but downward pressure on stock prices. Conversely, unanticipated decreases in inflation rates will have the opposite effects. Accordingly, it seems reasonable that forecasted errors in anticipated rates of inflation should have an impact upon stock prices; however, the existence of option contracts might well dampen this reaction.

Trading Volume

In describing the possible impacts that options contract expiration, unexpected changes in earnings and inflation might have on daily changes in the DJIA, little attention was paid to the pervasiveness of a particular forecasting error. That is, none of these variables directly captures the depth and breath of a particular announcement surprise. It is hypothesized that trading volume could serve as a proxy for the degree of this surprise.

For example, a totally unanticipated economic event would probably effect all market participants, albeit in varying degrees. As a result many individuals or institutions might take action to alter their stock ownership positions. An excellent indicator of portfolio restructuring is trading volume. Clearly then, the greater the degree of surprise the higher the volume. Recent research by Epps[31] strongly

---

[31] Thomas W. Epps, "Security Price Changes and Transaction Volumes: Theory and Evidence," American Economic Review, Vol. 65, No. 4 (September 1974), pp. 586-597 and __________, "The Distribution of Security Price Changes: A Test of a Volume-Mixture Model with Cauchy Disturbances," Operations Research, Vol. 28, No. 5 (September-October 1980), pp. 1205-1212.

supports this hypothesis. Therefore, trading volume was included as an explanatory variable.

III. Derivation of Expectational Variables

The previous section provided a theoretical justification for utilizing option expiration dates, unanticipated changes in inflation, errors in forecasted earnings, and trading volume to explain daily changes in the DJIA. To test these relationships, reasonable approximations for expected rates of inflation, and earnings are necessary. The earnings and inflation estimates presented in this study were derived via a set of univariate Box-Jenkins time series models.[32] The form and structure of these forecasting models is given in Table 4.

The first model described in Table 4 was used to forecast fourth quarter 1977 through third quarter 1978 earnings per share (EPS) for the DJIA. Quarterly EPS figures for the DJIA covering the period 1920-1979 were obtained from the editorial staff at Barron's. One significant adjustment was made to the data. In the fourth quarter 1977, Bethlehem Steel announced a negative quarterly EPS of \$10.92; \$8.45 of this loss was a one time charge. Accordingly, an upward adjustment for this extraordinary item was made to avoid biasing the EPS estimation series. Quarterly EPS figures from January, 1950 through September, 1977 were used to identify and estimate the DJIA's EPS figures. The Box-Jenkins EPS forecasting model utilized one seasonal difference of order four and one regular difference in conjunction with a moving average parameter of order four.

---

[32] George E. P. Box and Gwilyn M. Jenkins, Time Series Analysis: Forecasting and Control, Revis. Ed. (San Francisco: Holden Day, 1976).

TABLE 4

Box-Jenkins Forecasting Models*

Variable	Model Description	Algebraic Structure
Quarterly Earnings Per Share 1978: EPS	1 seasonal difference of order 4: $(1-B^4)$ 1 regular difference: $(1-B)$ 1 moving average parameter of order 4: Θ_t	$W_t = EPS_t(1-B)(1-B^4)$ $W_t = \Theta_1 u_{t-4} + u_t$ $= .783u_{t-4} + u_t$
1st and 2nd Quarter 90-day T-Bill Rates: r*	1 regular difference: $(1-B)$ 1 autoregressive parameter of order 2: ϕ_1	$W_t = r^*_t(1-B)$ $W_t = \phi_1 W_{t-2} + u_t$
3rd Quarter 90-day T-Bill Rate	1 regular difference: $(1-B)$ 1 autoregressive parameter of order 1: ϕ_1 1 moving average parameter of order 1: Θ_1	$W_t = r^*_t(1-B)$ $W_t = \phi_1 W_{t-1} + \Theta_1 u_{t-1} + u_t$
4th Quarter 90-day T-Bill Rate	1 regular difference: $(1-B)$ 1 trend parameter: δ	$W_t = r^*_t(1-B)$ $W_t = \delta + u_t$

*In this Table W_t is the series to be modeled and u_t is an error term.

The actual and forecasted EPS figures given in Table 5 indicate several interesting results. The actual earnings figure reported for the fourth quarter 1977 and third quarter 1978 are slightly below the forecasted values. In contrast, actual earnings for the first and second quarters are above the forecasts. In fact, the actual earnings for the second quarter fall outside the model's 95% forecasting confidence limits.

Because this study focuses upon daily price changes, it was necessary to partition these quarterly EPS errors into daily "announcements." These daily errors were derived by multiplying the quarterly EPS forecasting errors in Table 5 by the proportion of the DJIA corporations whose earnings were published in the Wall Street Journal (c.f. Table 3) on a particular day. For example, on January 20th, three corporations, Alcoa, Allied Chemical, and Westinghouse, announced their fourth quarter 1977 earnings. These corporations accounted for 1/10 of the total earnings announcements for that quarter. As a result, the earnings error for January 20th would be 1/10 times (.526) = ($ .0526).

The second, third, and fourth models given in Table 4 were used to estimate the average yield on the U.S. Treasury's weekly 90-day Treasury bill auctions during 1978. If as Fama[33] has shown, the short-term interest rates accurately mirror expected rates of inflation, it is possible to derive a proxy for unexpected changes in inflation by focusing upon interest rate forecasting errors. Therefore, weekly unexpected errors in

---

[33] Eugene F. Fama, "Short-Term Interest Rates," op. cit. and ________, "Rates and Inflation," op. cit.

TABLE 5

Actual and Forecasted EPS Figures for the DJIA

me Period	Actual	Forecast	Forecasting Error	95% Confidence Limits Lower	Upper	χ^2
'77	$23.49	$24.016	(.526)	$20.32	$27.71	9.31
'78	$22.04	$21.342	.698	$17.67	$25.01	9.60
'78	$29.66	$24.975	$4.685	$21.33	$28.62	9.37
I '78	$26.40	$27.587	(1.187)	23.82	31.36	12.391

forecasting inflation are derived by subtracting the ex ante (forecasted) average rate on the 90-day T-bill auction from the actual average yield. In turn, these weekly error terms were divided by five to obtain daily inflation error terms for the five previous trading days. Although it might appear that this procedure implies that the market reacts "today" to some future error, this conclusion is unwarranted. Assume that on Tuesday morning (the time when the auction's results are published) one makes an estimate via a Box-Jenkins model or some other alternative method of what next Tuesday's 90-day T-bill average auction rate will be. Based upon the current and forecasted yields, one can construct an expected daily adjustment path for 90-day rates over the next five days. As trading in the T-bill secondary market takes place, immediate feedback on the accuracy of one's forecast is given.

The Box-Jenkins interest rate models were identified using the previous 18 months' (seventy-eight weeks) observations. At the end of each quarter (thirteen weeks) a new model identification was attempted. This resulted in three models for four quarters. The first two quarters utilized regular differencing and one autoregressive parameter of order two. The third quarter model used first differences, one autoregressive term and one moving average parameter, both of order one. The fourth quarter model was based on first differences and contained only a trend parameter. Although the identification structure of the models was updated quarterly, the parameters of each model were recalculated each week. For ease of exposition, the values for these fifty-two parameter sets are omitted from Table 4.

IV. Empirical Results

Our statistical analysis focuses upon the ability of unanticipated errors in earnings and inflation estimates as well as option contract expiration dates, and trading volume to explain the daily changes in the DJIA.

Tables 6 and 7 contain the results of OLS regression analysis for daily price changes in the DJIA. The independent variables were errors (actual-forecast) in expected EPS and inflation, a dummy variable to control for proximity to option contract expiration, and daily trading volume. Tables 6 and 7 differ in a significant aspect. In Table 6, the errors in forecasted earnings were assumed to have been discovered on the day that a particular earnings announcement was published in the Wall Street Journal. In contrast, the results reported in Table 7 assume that these errors were "announced" on the day before publication. This "announcement" EPS error does not imply the existence of insider information. Instead, it presumes that earnings announcements are transmitted over the Dow-Jones news service network on the day before publication. This assumption is consistent with the results of a study by Reilly and Drzycimski on stock splits which showed a large announcement effect on the day before actual publication.[34]

In total six regressions are reported in both Tables 6 and 7. Except for the publication-announcement differences noted earlier, the

---

[34] Frank K. Reilly and Eugene F. Drzycimski, "Short-Run Profits from Stock Splits," Financial Management, forthcoming.

Table 6

OLS Regressions for the Daily Changes in the DJIA - 1978†

Dummy Variable Description	Constant	EPS Error (Publication)	Interest Rate Error	Option Expiration Dummy Variable	Trading Volume	Adjusted R^2	DW	F-Value
4 months 5 days before	-4.895 (-3.25)**	6.059 (1.12)	-34.067 (-3.16)**	-4.731 (-2.72)**	.0025 (3.66)**	.075	1.957	6.11**
8 months 5 days before	-4.661 (-3.09)**	5.352 (.986)	-30.237 (-2.86)**	-2.948 (-2.35)*	.0024 (3.55)**	.068	1.939	6.61**
4 months 5 days after	-4.752 (-3.11)**	5.997 (1.05)	-25.316 (-2.40)*	-.657 (-.372)	.0022 (3.26)**	.048	1.931	4.18**
8 months 5 days after	-4.771 (-3.11)**	5.038 (.85)	-26.333 (-2.44)*	.343 (.25)	.0022 (3.24)**	.049	1.926	4.16**
4 months 5 days around	-4.930 (-3.26)**	8.474 (1.52)	-29.212 (-2.78)**	-3.005 (-2.30)*	.0025 (3.06)**	.068	1.948	5.56**
8 months 5 days around	-4.497 (-2.95)**	7.227 (1.30)	-25.249 (-2.42)*	-1.666 (-1.66)	.0023 (3.41)**	.058	1.940	4.88**

†t-values are in parentheses: *-significant at .05 level; **-significant at .01 level.

Table 7

OLS Regressions for the Daily DJIA - 1978.

Dummy Variable Description	Constant	EPS Error (Announcement)	Interest Rate Error	Option Expiration Dummy Variable	Trading Volume	Adjusted R^2	DW	F-Value
4 months 5 days before	-4.781 (-3.19)**	11.416 (2.11)*	-33.810 (-3.16)**	-5.043 (2.90)**	.0024 (3.56)**	.087	1.945	6.99*
8 months 5 days before	-4.536 (-3.02)**	10.767 (1.99)*	-29.714 (-2.83)**	-3.147 (-2.51)*	.0023 (3.44)**	.079	1.927	6.42**
4 months 5 days after	-4.649 (-3.05)**	10.226 (1.83)	-24.621 (-2.35)*	-.787 (-.46)	.0021 (3.16)**	.057	1.920	4.77**
8 months 5 days after	-4.658 (-3.04)**	9.519 (1.71)	-22.522 (-2.38)*	.263 (.20)	.0021 (3.12)**	.056	1.916	4.73**
4 months 5 days around	-4.818 (-3.20)**	12.906 (2.32)*	-28.853 (-2.75)**	-3.228 (-2.49)*	.0024 (3.57)**	.079	1.941	6.39**
8 months 5 days around	-4.357 (-2.87)**	11.666 (2.10)*	-24.570 (-2.37)*	-1.816 (-1.82)	.0022 (3.31)**	.068	1.925	5.61**

† t-values are in parenthesis: *-significant at .05 level; **-significant at .01 level.

respective equations in these Tables are identical. Within each Table the only independent variable to change is the option-expiration dummy or indicator variable. The first equation contains a four month dummy whose value was one on the five trading days preceding the 1978 option contract expiration dates in January, April, July, and October. Otherwise, the variable's value was zero. The second equation also contains a "five preceeding days" dummy variable; however, the variable was inserted for eight months, January, February, April, May, July, August, October, and November.[35]

The third and fourth equations contain similar four month and eight month dummy variables, respectively, but these dummy variables take the value one for the five trading days <u>after</u> the appropriate expiration dates. Otherwise their value is zero. Finally, the value for the four and eight month dummy variables in the last two equations is one if a particular day is five trading days <u>on either side</u> of an appropriate contract expiration date. Otherwise, the values of these variables are zero.

The results in Table 6 point to several interesting conclusions. First, although the coefficient of the EPS error term has the expected sign, none of the coefficients is statistically different from zero. In contrast, the interest rate or inflation error term is consistently significant. Further the absolute value of these coefficients were surprisingly large. The trading volume coefficients were consistently positive and statistically significant,

---

[35]Recall from Table 1 that four of the DJIA's components had contracts that expired during February, May, August, and November.

which supports the conclusions reached by Epps.[36] Perhaps the most interesting results in Table 6 are the coefficients of the option expiration dummy variables. The coefficients of both the four and eight month, five "preceeding days" variable are negative and statistically significant which confirms Klemkosky's findings.[37] On the other hand, the coefficients of the five "subsequent days" variables are positive and negative for the four and eight month variables, respectively, but neither of the coefficients is significant. Finally, the coefficients for the ten days surrounding the option expiration date are negative, but only the four month variable is significant. On balance, these results indicate that, ceteris paribus, prior to the expiration of option contracts the prices of underlying securities tends to fall while there is no strong tendency for recovery after expiration. Therefore, the net effect of option expirations is to depress daily security price changes.[38] Notably, autocorrelation is not a problem for any of the equations, and the F-values are respectible. Although the adjusted coefficients of determination are rather low, these results were not surprising given the random walk characteristics of daily stock price changes.

---

[36] Thomas W. Epps, "Security Price Changes," op. cit.

[37] Robert C. Klemkosky, "The Impact of Option Expirations," op. cit.

[38] Even though earnings errors are included in the model, it is possible that option expiration dummy variables might capture an alternative effect, uncertainty created by earnings' announcements. (See James E. Patell and Mark A. Wolfson, "Anticipated Information Releases," op. cit as well as __________ and __________, "Preliminary Evidence of the Effect of Quarterly Earnings and Dividend Announcements," op. cit.) However, a careful comparison of the 1978 quarterly earnings announcement and publication dates for the DJIA (c.f. Table 3) with the option expiration dates given in footnote 12, indicates little, if any basis for this hypothesis.

The results given in Table 7 with one remarkable exception are in basic agreement with those seen previously. The coefficients and the statistical significance of the interest rate error, option expiration, and trading volume variables are almost identical to those seen in Table 6. Again autocorrelation is not a problem, and the explanatory power of the equations is respectable given the erratic nature of daily changes in DJIA. The unique result in Table 7 is the coefficients for the EPS "announcement" errors which are all positive, and four of the six are significant. Regarding market efficiency, the implications of these results are astounding. Specifically, they imply that by the time earnings announcements appear in the Wall Street Journal, this "new" information is already incorporated into stock prices.

Summary and Conclusions

The purpose of this research has been to focus upon the impacts that the expiration of option contracts, errors in forecasts for earnings and inflation, and trading volume have had upon daily changes in a widely recognized index of the U.S. stock market, the Dow-Jones Industrial Average. The results of the analysis point to several interesting conclusions. First it appears that the expiration of option contracts, *ceteris paribus*, actually depress daily changes in the DJIA. From an economic perspective, this is perfectly logical and confirms the Klemkosky's hypothesis.[39]

---

[39] Robert C. Klemkosky, "The Impact of Option Expiration," *op. cit.*

Our analysis also provided support for the impact of unanticipated changes in the rate of inflation and the efficiency with which the market processes accounting information. Our parameter estimates consistently confirmed the dramatic effect that inflation plays in determining the direction of equity prices. From a more practical perspective, our analysis also implies that if inflation can be brought under control, U.S. equity markets are likely to experience one of the greatest bull markets in history.

In contrast to many prior studies that have focused upon the efficiency with which the market processes accounting and financial information this research utilizes daily information. Our results indicate a surprisingly strong degree of market efficiency which points to the conclusion that by the time earnings announcements appear in the Wall Street Journal, it is probably too late to react to this "new" information.