Seasonal Effects in S&P 100 Index Option Returns

John S. Cotner
Nandkumar Nayar

INTRODUCTION

Recent investigations have provided substantial evidence of three different types of seasonality effects in the return patterns on a variety of securities. These seasonalities are generally referred to as the *January effect,* the *monthly effect,* and the *day-of-the-week effect.*

The January effect refers to security returns being consistently higher in January than in other months. This is called the *early January effect* when the higher returns are realized mainly in the first five trading days of January. The reason for the persistence of this seasonality in returns has not been fully determined. While Keim (1983) provides evidence that the January effect is related to tax-loss selling, Reinganum (1983) and others conclude tax considerations alone do not provide sufficient rationale for the higher returns.

The monthly effect refers to returns generally being higher in the earlier part than in the latter part of a calendar month. Ariel (1987) provided evidence of this effect in stocks, showing that the mean return is positive in the first half of trading months but not significantly different from zero in the last half of trading months.

The day-of-the-week effect refers to returns not being homogeneously distributed over the days of the week. As shown by French (1980) and others, the returns on stocks tend to be lower (actually, negative) on Mondays than on other days of the week. Flannery and Protopapadakis (1988) found further evidence of this effect in Treasury securities as well as in stock indices. This seasonality is not explained by broad economic forces nor by institutional features of the securities.

Return seasonalities have been widely observed on United States stocks, various U.S. stock indices, U.S. Treasury bills, foreign exchange rates, and foreign stock markets. Dickinson and Peterson (1989) provided evidence of similar effects in options on individual stocks. However, research on seasonal effects with respect to returns on index options has not been presented. The purpose of this research is to determine whether

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John S. Cotner is an Associate Professor of Finance at Loyola College in Maryland.

Nandkumar Nayar is an Assistant Professor of Finance at The University of Oklahoma.

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the types of return seasonality noted in other securities is manifest with options on a broad-based market index.[1]

Trading in index options began in 1983. As early as 1986 the volume of index options gave rights to underlying assets worth more than double the volume on the NYSE. Options on the S&P 100 index (OEX) are now the most widely traded contract on the CBOE, with daily volume frequently exceeding 600,000 contracts and open interest exceeding one million contracts. Many, if not most, investment managers employ S&P 100 index options in managing the risk of common stock portfolios. Consequently, the identification of seasonal effects in this widely used, heavily traded instrument may have important implications for constructing investment strategies.

Grounded largely on the work of Merton (1973) and Black and Scholes (1973), the value of an option can be shown to be based on the exercise price of the option, market price of the underlying asset, time to expiration, standard deviation of returns on the underlying asset, and the risk-free rate of interest. Previous analyses of index option prices indicate that returns are sensitive to all of these factors except the risk-free rate. Therefore, this study controls for these other factors in investigating return seasonality in index options.

DATA AND VARIABLES FOR ANALYSIS

Index options began trading in March, 1983, when the Chicago Board Options Exchange (CBOE) introduced options on the S&P 100 index. While several other index options have been introduced subsequently, the S&P 100 remains the most widely traded. Daily volume exceeds that of all other index options combined. Accordingly, the S&P 100 index option contract is employed in this research.

The reported "closing" prices for call options on the S&P 100 index and the level of the index are from the CBOE for each trading day from October 10, 1985 through June 30, 1989. Several adjustments are then made to this data set. First, options which violated the lower arbitrage pricing boundary are removed. Then, options which had less than 14 days to expiration and/or closing prices of less than \$0.30 are excluded.[2] Next, option contracts expiring in the period from October to December, 1987 are omitted.[3] Finally, trading days immediately preceded by a non-weekend holiday are deleted. [See Cornell (1985) and Dyl and Maberly (1986).] Further, computing a one-day return required a reported closing price both on the observation day and on the prior trading day. A total of 17,237 usable observations remain after these adjustments. An observation refers to the one-day return on an index call option having a specific exercise price and specific expiration date.

Day and Lewis (1988) show that the dividend-adjusted version of the option pricing model presented by Black and Scholes (1973) is appropriate for call options written on a broad-based stock index. Harvey and Whaley (1992) demonstrate that accounting for discrete dividend payouts on the stocks that comprise the S&P 100 index is important

[1]The scope of this article is limited to the examination of seasonal effects in index option returns. The study does not explore the potential for investors to generate excess returns from these seasonalities.

[2]Analysis of the data shows that returns for options with very short terms to expiration and/or extremely low prices have undue influence on means rates of returns for various groups of options. Excluding these observations removes potential bias in the results. Day and Lewis (1988) provide evidence that options on three different indices exhibit increased implied volatility around expiration dates. An in-depth discussion of expiration day effects can be found in their article.

[3]This period is excluded due to the extraordinary volatility in the pricing of index options associated with the market "crash" in October, 1987.

in explaining changes in the market prices of options on this index. Thus, the dividend-adjusted version of Black–Scholes model is used in estimating the standard deviation of returns on the S&P 100 index on each day included in the analysis. This can be written as:

$$C = (S - D)^* N(d1) - Xe^{-rt*} N(d2) \tag{1}$$

where
C = value of call option,
S = current level of the index,
D = present value of all dividends paid during option's time remaining to expiration,
X = exercise price of the option,
r = risk-free rate over the time to expiration,
t = time to expiration,
σ^2 = variance of returns on the index,
$d1 = \{\ln[(S - D)/Xe^{-rt}] + (r + \sigma^2/2)t\}/\sigma\sqrt{t}$,
$d2 = d1 - \sigma\sqrt{t}$, and
$N(\cdot)$ = cumulative normal density function.

A Newton–Ralphson iterative procedure is employed to calculate a model price to within \$0.01 of the closing market price of the index option on the previous trading day. [See Manaster and Koehler (JF, 1982).][4] This derives the standard deviation of the index implied by the lagged market price of the option and thus, provides an ex ante estimate of index volatility over the time to expiration of the option. The risk-free rates of interest used in computing the implied standard deviations are the one-month U.S. Treasury Bill rates.

THE METHOD OF ANALYSIS

Assuming the closing price of a specific call option on a given day (C_t) is the same as the opening price of that option on the following day, the one-day return from buying each option at opening and selling it at closing on a given day (R_t) is calculated as:

$$R_t = (C_t/C_{t-1}) - 1 \tag{2}$$

These one-day returns are then used in the subsequent tests for return seasonalities.

The January Effect

To examine index option returns for a *January effect,* i.e., whether returns in January are significantly different from returns in other months, the following regression model is estimated using the ordinary least squares technique:

$$R_t = \alpha_0 + \alpha_J \mathrm{JAN}_t + e_t \tag{3}$$

where
R_t is the one-day return on the call option,
JAN_t is 1 if day t is in January and zero otherwise,
α_0, α_J are the coefficients to be estimated, and
e_t is an error term.

[4]Campbell Harvey of Duke University provided the discrete dividend data used in this analysis. In a prior version of this article, implied standard deviations were computed assuming a constant dividend rate. Using discrete dividend data led to higher adjusted R^2 and statistical significance in the coefficient estimates for the seasonality tests. See Harvey and Whaley (1991) for other issues in computing implied standard deviations of OEX options.

If returns in January are different from returns in other months, then α_J will be different from zero.[5]

To determine whether any seasonality noted in option returns is robust to the principal option pricing determinants, eq. (2) is expanded by adding additional explanatory variables for *moneyness,* time to expiration, and standard deviation. The expanded versions of this model are shown as:

$$R_t = \alpha_0 + \alpha_J \text{JAN}_t + \alpha_M \text{MON}_t + e_t, \tag{3A}$$

$$R_t = \alpha_0 + \alpha_J \text{JAN}_t + \alpha_E \text{EXP}_t + e_t, \quad \text{and} \tag{3B}$$

$$R_t = \alpha_0 + \alpha_J \text{JAN}_t + \alpha_S \text{STD}_t + e_t \tag{3C}$$

where MON_t is the moneyness of the option on day t, calculated as: (level of S&P 100 index on day t/strike price) $- 1$,
EXP_t is the number of days to expiration of the option, and
STD_t is the implied standard deviation of the index, computed using eq. (1) from the previous day's closing call option price.

Finally, all three option pricing factors are combined to give an extended model shown as:

$$R_t = \alpha_0 + \alpha_J \text{JAN}_t + \alpha_M \text{MON}_t + \alpha_E \text{EXP}_t + \alpha_S \text{STD}_t + e_t \tag{3D}$$

To investigate for an *early January effect,* eq. (3) is expanded by adding a variable for an observation in the first five trading days in January. The estimated model is shown as:

$$R_t = \alpha_0 + \alpha_J \text{JAN}_t + \alpha_F \text{FIV}_t + e_t \tag{4}$$

where FIV_t is 1 if day t is in the first five trading days of January and zero otherwise.

In a manner parallel to that for eq. (3), the variables for moneyness, time to expiration and standard deviation are added to eq. (4) one at a time. Thus:

$$R_t = \alpha_0 + \alpha_J \text{JAN}_t + \alpha_F \text{FIV}_t + \alpha_M \text{MON}_t + e_t, \tag{4A}$$

$$R_t = \alpha_0 + \alpha_J \text{JAN}_t + \alpha_F \text{FIV}_t + \alpha_E \text{EXP}_t + e_t, \tag{4B}$$

$$R_t = \alpha_0 + \alpha_J \text{JAN}_t + \alpha_F \text{FIV}_t + \alpha_S \text{STD}_t + e_t, \quad \text{and} \tag{4C}$$

$$R_t = \alpha_0 + \alpha_J \text{JAN}_t + \alpha_F \text{FIV}_t + \alpha_M \text{MON}_t + \alpha_E \text{EXP}_t + \alpha_S \text{STD}_t + e_t \tag{4D}$$

As above, analysis of the data with these models will indicate whether any noted seasonality is robust when one controls for the option pricing determinants.

The Monthly Effect

To examine index option returns for an indication of a *monthly effect,* the following model is estimated:

$$R_t = \alpha_0 + \alpha_N \text{MTH}_t + e_t \tag{5}$$

[5]To account for any possible heteroscedasticity, White's (1980) correction is used also to arrive at the asymptotic covariance matrix. The square roots of the diagonal terms of this matrix are used to compute revised t-statistics. Both t-statistics for all the regressions conducted in this paper are reported in the results.

where MTH_t is 1 if day t is in the first 10 days of the calendar month and zero otherwise.

As with eqs. (3) and (4), this model is expanded to consider moneyness, time to expiration, and standard deviation, giving:

$$R_t = \alpha_0 + \alpha_N MTH_t + \alpha_M MON_t + e_t, \tag{5A}$$

$$R_t = \alpha_0 + \alpha_N MTH_t + \alpha_E EXP_t + e_t, \tag{5B}$$

$$R_t = \alpha_0 + \alpha_N MTH_t + \alpha_S STD_t + e_t, \quad \text{and} \tag{5C}$$

$$R_t = \alpha_0 + \alpha_M MTH_t + \alpha_N MON_t + \alpha_E EXP_t + \alpha_S STD_t + e_t \tag{5D}$$

Again, the purpose here is to determine whether return seasonality is robust when controlling for the option pricing determinants.

The Day-of-the-Week Effect

Examination of the returns for a *day-of-the-week-effect* (whether returns on Mondays are different than for other days of the week) is effected through a model shown as:

$$R_t = \alpha_0 + \alpha_D DAY_t + e_t \tag{6}$$

where DAY_t is 1 if day t is Monday and zero otherwise.

Similarly to the above equations, this model is estimated after controlling for the three option pricing determinants:

$$R_t = \alpha_0 + \alpha_D DAY_t + \alpha_M MON_t + e_t, \tag{6A}$$

$$R_t = \alpha_0 + \alpha_D DAY_t + \alpha_E EXP_t + e_t, \tag{6B}$$

$$R_t = \alpha_0 + \alpha_D DAY_t + \alpha_S STD_t + e_t, \quad \text{and} \tag{6C}$$

$$R_t = \alpha_0 + \alpha_D DAY_t + \alpha_M MON_t + \alpha_E EXP_t + \alpha_S STD_t + e_t \tag{6D}$$

Combined Effects

It is possible, of course, that more than one type of return seasonality may be in evidence at the same time. To investigate this possibility, a model which includes variables for all three types of seasonal effects is tested. This model is shown as:

$$R_t = \alpha_0 + \alpha_J JAN_t + \alpha_F FIV_t + \alpha_N MTH_t + \alpha_D DAY_t + e_t \tag{7}$$

Adding the variables for moneyness, time to expiration, and standard deviation gives an expanded version of (7), shown as:

$$R_t = \alpha_0 + \alpha_J JAN_t + \alpha_F FIV_t + \alpha_N MTH_t + \alpha_D DAY_t + \alpha_I MON_t + \alpha_E EXP_t + \alpha_S STD_t + e_t \tag{7A}$$

Effects in Returns on Index

To determine if any of the seasonal effects noted in the index options is also manifest in returns on the index, the one-day returns on the S&P 100 index (RS_t) is examined using a model shown as:

$$RS_t = \beta_0 + \beta_J JAN_t + \beta_F FIV_t + \beta_N MTH_t + \beta_D DAY_t + e_t \tag{8}$$

This equation is estimated using observations of the returns on the S&P 100 index corresponding to the 17,237 observations of index call option returns.

RESULTS OF THE ANALYSIS

The January Effect

Results from analyzing the data for the January effect in index option returns are summarized in Table I. In all rows of the table, the t-value associated with α_J indicates the mean return on index options in January is significantly higher ($p < 0.0001$) than in other months of the year. This result holds even after controlling for moneyness, time to expiration, and standard deviation of the index. This January effect in index option returns is also evident in Table II, which is based on the examination of all three types of return seasonality together. The coefficient α_J is significant ($p < 0.0001$) both when the three option pricing factors are included in the model (row 2) and when these factors are excluded (row 1).

Returns on the S&P 100 index also exhibit a strong January effect. As shown in Table III (rows 1, 2, and 3) the mean return on the index in January is significantly higher ($p < 0.0001$) relative to returns in other months. While the January effect on index option returns is consistent with the January effect on the underlying index, the point estimates for the return differential on the options (about 4%) is notably higher than that for the index (about 0.2%). These results are consistent with the belief that investments in call options are substantially more leveraged than investments in the underlying asset and hence should provide a higher mean return.

The Early January Effect

The results associated with the early January effect are displayed in Table IV. In all versions of the model used to investigate this effect, the mean returns on index options during the first five trading days in January is significantly higher ($p < 0.0001$) than on other days. It is notable that this early January effect persists despite the significant variable for the January effect being included in the model (row 2). This implies that the returns in the first five days of January are not only significantly higher than returns in other months but also markedly higher than returns on other days in January. As with the January effect, these results are robust to controlling separately for moneyness, time to expiration, and the standard deviation of the index returns (rows 3–5) and when considering all three of these factors together (row 1).

Further, this early January effect is revealed even when including all types of return seasonality together. In Table II the coefficient α_F is significant ($p < 0.0001$) both when moneyness, time to expiration, and standard deviation are included in the model (row 2) and when these factors are excluded (row 1).

A similar seasonal pattern is exhibited in the returns on the S&P 100 index. As shown in Table III, the returns on the index are significantly higher ($p < 0.0001$) during the first five days of January than on all other days. Like the January effect, this effect is robust even when considering all three types of return seasonality together (row 1). Again, the estimated return differential on the options during the first five days in January (about 10%) is markedly higher than that for the index (about 0.5%).

Table I

REGRESSION STATISTICS FOR JANUARY EFFECT IN INDEX CALL OPTIONS[a]

$(R_t = \alpha_0 + \alpha_J \mathrm{JAN}_t + \alpha_M \mathrm{MON}_t + \alpha_E \mathrm{EXP}_t + \alpha_S \mathrm{STD}_t + e_t)$

Row[b] (No. Obs. = 17,237)	α_0	α_J	α_M	α_E	α_S	F-Value	Adj. R^2
1	0.0925 (12.451) (13.743)	0.0494 (9.351) (8.343)	0.3473 (14.105) (15.081)	−0.0002 (−3.001) (−2.912)	−0.3274 (−15.449) (−20.801)	130.986	0.0293
2	0.00658 (4.275) (4.325)	0.05577 (10.453) (9.4353)				109.265	0.0062
3	0.00455 (2.955) (2.866)	0.0527 (9.915) (8.882)	0.2967 (12.352) (14.386)			131.398	0.0149
4	0.00306 (0.902) (0.798)	0.0555 (10.401) (9.371)		0.00006 (1.163) (1.156)		55.31	0.0063
5	0.0664 (14.009) (18.402)	0.05312 (10.000) (9.009)			−0.2512 (−13.336) (−17.685)	144.122	0.0163

[a]For each cell, t-value is in first parenthesis; White-adjusted t-values in second parenthesis.

[b]Row 1: Model includes all factors; Row 2: Model includes only January; Row 3: Model includes January and moneyness; Row 4: Model includes January and expiration; Row 5: Model includes January and standard deviation.

Table II

REGRESSION STATISTICS FOR ALL EFFECTS IN INDEX CALL OPTIONS[a]

$(R_t = \alpha_0 + \alpha_J \text{JAN}_t + \alpha_F \text{FIV}_t + \alpha_N \text{MTH}_t + \alpha_D \text{DAY}_t + \alpha_M \text{MON}_t + \alpha_E \text{EXP}_t + \alpha_S \text{STD}_t + e_t)$

Row[b] (No. Obs. = 17,237)	α_0	α_J	α_F	α_N	α_D	α_M	α_E	α_S	*F*-Value	Ajd. R^2
1	0.00634	0.051	0.0976	0.0074	−0.0127					
	(3.157)	(9.363)	(4.281)	(2.360)	(−3.326)					
	(3.280)	(8.523)	(3.696)	(2.335)	(−3.493)				37.050	0.0083
2	0.0947	0.044	0.1047	0.0071	−0.0157	0.3468	−0.00019	−0.3343		
	(12.530)	(8.193)	(4.643)	(2.268)	(−4.170)	(14.099)	(−3.030)	(−15.766)		
	(13.841)	(7.390)	(3.893)	(2.234)	(−4.420)	(15.062)	(−2.943)	(−21.369)	81.945	0.0318

[a]For each cell, *t*-value is in first parenthesis; White-adjusted *t*-values in second parenthesis.

[b]Row 1: Model includes factors for effects and for option pricing determinants; Row 2: Model includes only factors for effects.

The Monthly Effect

Based on the results shown in Table V, index option returns during the first 10 days of a calendar month do appear to be positive and higher than returns on the other days of the month. However, the confidence level for the monthly effect (row 2) is much lower (smaller t-values) than with the January and early January effects. The same results obtain when one separately controls for moneyness, time to expiration, and standard deviation (rows 3–5), and when all three option pricing determinants are put together (row 1).

When including all three types of return seasonality in the model (see rows 1 and 2 of Table II) the monthly effect in index option returns is still significant, but the level of confidence is not as high as for the January effect and the early January effect.

As shown in Table III (rows 1 and 4) the returns on the S&P 100 index are not significantly different during the first 10 days of a calendar month from the other days of the month. Thus, the monthly effect apparent in returns on index options is not observed in returns on the underlying index.

The Day-of-the-Week Effect

Table VI provides clear evidence for a significant day-of-the-week in index options. In all rows the coefficient α_D is significant ($p < 0.001$) and *negative.* This implies the mean returns on index options are lower on Mondays than on other days of the week. The Monday effect persists even when all the different seasonal effects are included in the model (see rows 1 and 2 of Table II).

Table III
REGRESSION STATISTICS FOR ALL EFFECTS ON S&P 100 INDEX[a]
$(R_t = \beta_0 + \beta_J \mathrm{JAN}_t + \beta_F \mathrm{FIV}_t + \beta_N \mathrm{MTH}_t + \beta_D \mathrm{DAY}_t + e_t)$

Row[b] (No. Obs. = 17,237)	β_0	β_J	β_F	β_N	β_D	F-Value	Adj. R^2
1	0.00082 (8.427) (8.146)	0.0021 (7.719) (7.305)	0.0048 (4.371) (7.193)	0.000198 (1.297) (1.320)	−0.0009 (−5.075) (−5.344)	32.135	0.0072
2	0.000714 (9.609) (9.634)	0.0023 (8.866) (8.597)				78.61	0.0045
3	0.000714 (9.615) (9.634)	0.0020 (7.603) (7.281)	0.00516 (4.710) (7.915)			50.448	0.0057
4	0.00085 (9.695) (9.418)			0.00018 (1.159) (1.191)		1.343	0.0000
5	0.0011 (13.713) (13.533)				−0.0010 (−5.244) (−5.515)	27.495	0.0015

[a]For each cell, t-value is in first parenthesis; White-adjusted t-values in second parenthesis.

[b]Row 1: Model includes all factors; Row 2: Model includes only factor for January; Row 3: Model includes factor for January and early January; Row 4: Model includes only factor for month; Row 5: Model includes only factor for day.

Table IV
REGRESSION STATISTICS FOR EARLY JANUARY EFFECT IN INDEX CALL OPTIONS[a]

$(R_t = \alpha_0 + \alpha_J \text{JAN}_t + \alpha_F \text{FIV}_t + \alpha_M \text{MON}_t + \alpha_E \text{EXP}_t + \alpha_S \text{STD}_t + e_t)$

Row[b] (No. Obs. = 17,237)	α_0	α_J	α_F	α_M	α_E	α_S	F-Value	Adj. R^2
	0.0924	0.0433	0.1135	0.3484	−0.0002	−0.3287		
1	(12.451)	(7.989)	(5.066)	(14.158)	(−2.896)	(−15.519)	110.07	0.0307
	(13.735)	(7.198)	(4.244)	(15.140)	(−2.820)	(−20.899)		
2	0.0066	0.0501	0.1062					
	(4.278)	(9.155)	(4.689)					0.0075
	(4.325)	(8.323)	(4.045)				65.692	
	0.0045	0.0470	0.1064	0.2968				
3	(2.957)	(8.625)	(4.719)	(12.363)				0.0161
	(2.866)	(7.790)	(3.978)	(14.397)			95.130	
	0.0027	0.0498	0.1071		0.00007			
4	(0.783)	(9.090)	(4.724)		(1.297)			0.0075
	(0.693)	(8.251)	(4.072)		(1.289)		44.357	
	0.0669	0.0470	0.1132			−0.2534		
5	(14.126)	(8.634)	(5.023)			(−13.458)		0.077
	(18.860)	(7.847)	(4.298)			(−17.877)	104.627	

[a]For each cell, t-value is in first parenthesis; White-adjusted t-values in second parenthesis.

[b]Row 1: Model includes all factors; Row 2: Model includes only factors for January and early January; Row 3: Model includes factors for January, early January, and moneyness; Row 4: Model includes factors for January, early January, and expiration; Row 5: Model includes factors for January, early January, and standard deviation.

Table V

REGRESSION STATISTICS FOR MONTHLY EFFECT IN INDEX CALL OPTIONS[a]

$(R_t = \alpha_0 + \alpha_N \mathrm{MTH}_t + \alpha_M \mathrm{MON}_t + \alpha_E \mathrm{EXP}_t + \alpha_S \mathrm{STD}_t + e_t)$

Row[b] (No. Obs. = 17,237)	α_0	α_N	α_M	α_E	α_S	F-Value	Adj. R^2
	0.0946	0.0065	0.3602	−0.00017	−0.3327		
1	(12.640)	(2.106)	(14.615)	(−2.701)	(−15.685)	109.711	0.0246
	(13.823)	(2.068)	(15.701)	(−2.625)	(−21.048)		
	0.0091	0.0065					
2	(5.002)	(2.075)				4.304	0.0002
	(5.075)	(2.046)					
	0.0069	0.0059	0.3071				
3	(3.798)	(1.913)	(12.764)			83.629	0.0095
	(3.739)	(1.882)	(14.926)				
	0.0043	0.0065		0.00008			
4	(1.221)	(2.070)		(1.552)		3.357	0.0003
	(1.099)	(2.041)		(1.543)			
	0.0703	0.0070			−0.2586		
5	(14.593)	(2.239)			(−13.707)	96.118	0.0109
	(18.559)	(2.196)			(−18.226)		

[a]For each cell, t-value is in first parenthesis; White-adjusted t-values in second parenthesis.

[b]Row 1: Model includes all factors; Row 2: Model includes only factor for month; Row 3: Model includes factors for month and moneyness; Row 4: Model includes factors for month and expiration; Row 5: Model includes factors for month and standard deviation.

Table VI

REGRESSION STATISTICS FOR DAY-OF-THE-WEEK EFFECT IN INDEX CALL OPTIONS[a]

$(R_t = \alpha_0 + \alpha_D \mathrm{DAY}_t + \alpha_M \mathrm{MON}_t + \alpha_E \mathrm{EXP}_t + \alpha_S \mathrm{STD}_t + e_t)$

Row[b] (No. Obs. = 17,237)	α_0	α_D	α_M	α_E	α_S	F-Value	Adj. R^2
	0.1012	−0.0165	0.3603	−0.0002	−0.3380		
1	(13.491)	(−4.364)	(14.630)	(−2.774)	(−15.893)		
	(14.807)	(−4.631)	(15.732)	(−2.690)	(−21.465)	113.454	0.0254
	0.0137	−0.0134					
2	(8.364)	(−3.507)				12.297	0.0007
	(8.261)	(−3.685)					
	0.0112	−0.0129	0.3069				
3	(6.852)	(−3.394)	(12.759)				
	(6.463)	(−3.576)	(14.920)			87.598	0.0099
	0.0089	−0.0134		0.00009			
4	(2.563)	(−3.517)		(1.583)		7.401	
	(2.240)	(−3.700)		(1.575)			0.0007
	0.0765	−0.0163			−0.2628		
5	(15.930)	(−4.287)			(−13.904)		
	(21.197)	(−4.541)			(−18.622)	102.872	0.0117

[a]For each cell, t-value is in first parenthesis; White-adjusted t-values in second parenthesis.

[b]Row 1: Model includes all factors; Row 2: Model includes only factor for day; Row 3: Model includes factors for day and moneyness; Row 4: Model includes factors for day and expiration; Row 5: Model includes factors for day and standard deviation.

As shown in Table III, rows 1 and 5, returns on the S&P 100 index also exhibit a significant (albeit smaller) Monday effect, even when the other seasonal effects are included.

SEASONAL EFFECTS IN RETURNS FROM IMPLIED INDEX LEVELS

It can be argued that the results for index option returns analyzed in the prior sections derive partly from their nature as a leveraged investment in the underlying index. Therefore, this study investigates whether seasonality is present in returns to the implied index level computed from index option prices. The motivation for this is that, while incremental information in index options should be reflected in returns on the implied index, the effects of leverage are eliminated.[6]

The dividend-adjusted version of the Black–Scholes option pricing model [see eq. (1)] is employed to simultaneously compute the index level and volatility implied by call option prices on a daily basis.[7] The two closest-to-the-money options on any day which had at least 14 but not more than 70 days to expiration are used in this computation.[8] Implied one-day returns were then computed for this implied index series. The series of implied index returns, denoted RI_t, are then used as the dependent variable in various regression models, the general form of which is:

$$RI_t = \alpha_0 + \alpha_J \mathrm{JAN}_t + \alpha_F \mathrm{FIV}_t + \alpha_N \mathrm{MTH}_t + \alpha_D \mathrm{DAY}_t + e_t \tag{9}$$

Results of the analysis for the implied index series are shown in Table VII. In rows 1 and 5 coefficients for the indicator variable for the January effect are positive and significant. Thus, returns on the implied index series are higher in January than in other months, a result which is consistent with the January effect noted in the options and in the actual index.

As shown in rows 2 and 5 of Table VII, coefficients for the variable representing the early January effect are not statistically significant. Therefore, returns on the implied index series do not display the early January effect exhibited in returns on index options and in returns on the actual index.

For the monthly effect, the associated coefficients (rows 3 and 5 in Table VII) are negative and significant. This means that returns on the implied index series are lower in the first 10 days of a calendar month than in the rest of the month, a result opposite that for returns on index options. This effect is not significant for returns on the index.

The coefficients for the day-of-the-week effect, shown in rows 4 and 5 of Table VII, are not statistically significant. Thus, the significantly lower returns on Mondays than on other days of the week which are observed for index options are not found in returns on the implied index series.

While seasonal effects are present in all three one-day return series analyzed in this research, the significance of these effects differs across series. Only the January effect is significant in all three series. The early January effect and day-of-the-week effect are noted in both the option returns and returns on the actual index. However, neither effect is significant in returns on the implied index. The monthly effect is not significant in returns on the actual index; is *positive* and significant for returns on the options; and is *negative* and significant for returns on the implied index series.

[6]This argument, as well as the analysis that follows, was suggested by an anonymous referee.

[7]This non-linear equation system is solved iteratively to minimize the sum of the squared deviations of the model call prices from the actual call prices. Seed values for each day are the actual index level and the standard deviation computed in the prior analysis for the nearest-to-the-money option.

[8]Exclusion rules used to constrain the sample, as explained in a prior section, also apply here.

Table VII
REGRESSION STATISTICS FOR ALL EFFECTS
USING RETURNS ON THE IMPLIED INDEX LEVEL[a]
($RI_t = \alpha_0 + \alpha_J \text{JAN}_t + \alpha_F \text{FIV}_t + \alpha_N \text{MTH}_t + \alpha_D \text{DAY}_t + e_t$)

Row (No. Obs. = 818)	α_0	α_J	α_F	α_N	α_D	Adj. R^2
1	−0.0014	0.0091				0.013
	(−2.220)	(3.332)				(11.10)
2	−0.0014	0.0091	−0.0057			0.012
	(−2.218)	(3.330)	(−0.027)			(5.54)
3	0.0006			−0.0043		0.013
	(0.778)			(−3.310)		(10.96)
4	−0.006				−0.0019	0.0002
	(−0.956)				(−1.066)	(1.137)
5	0.0005	0.0096	−0.0036	−0.0046	−0.0021	0.0276
	(0.630)	(3.535)	(−0.017)	(−3.602)	(−1.216)	(6.315)

[a]For each cell, t-value is in parenthesis.

SUMMARY

The objective of this research is to determine whether the types of return seasonality observed in other securities is present in returns on index options. Because index option prices are sensitive to moneyness, time to expiration, and standard deviation of the index, these factors are controlled for in the analysis.

To investigate for a *January effect,* a *monthly effect,* and a *day-of-the-week* effect in index option returns, the one-day returns for S&P 100 index call options over the period October 10, 1985 through June 30, 1989 are analyzed. Data for the fourth quarter of 1987 and for very short-term, low-priced options are excluded. A series of regression models are employed to determine whether significant seasonality is displayed in these returns.

Results of the analyses indicate the presence of a January effect, an *early January effect,* and a day-of-the-week effect in S&P 100 index option returns. These effects are significant even when controlling for moneyness, time to expiration, and standard deviation of the index. These seasonalities are also significant in returns on the underlying index itself. Since the price of a call option is a positive function of the index level, it is not surprising that both the options and the index would exhibit these effects.

While this analysis does indicate a significant monthly effect in returns on index options, a monthly effect is not observed in returns on the index. The results for the options are substantially the same whether or not one controls for moneyness, time to expiration, and/or standard deviation of returns on the underlying index. These results are also robust to heteroscedasticity correction using White's (1980) method.

Since the return on a stock index option can be construed as representing a return to a levered position in the underlying index, an additional analysis considers returns on an implied index series which is estimated, simultaneously with index variance, from call option prices. Like returns on the options and on the actual index, returns on this derived implied index return series reveals a January effect. However, neither an early

January effect nor a day-of-the-week effect is present in this implied return series. In contrast to returns on the options, the monthly effect is *negative* and significant in the implied index returns.

As with seasonal effects observed in returns on other securities, the reason for these effects persisting in returns on S&P 100 index call options, as well as in returns on the underlying index and on the implied index, is not immediately obvious. Further investigation and explanation for these effects must remain the subject of future research.

Bibliography

Ariel, R. (1987, March): "A Monthly Effect in Stock Returns," *Journal of Financial Economics,* 18:161–174.

Black, F., and Scholes, M. (May, 1973): "The Pricing of Options and Corporate Liabilities," *Journal of Political Economy,* 81:637–654.

Cornell, B. (1985, June): "The Weekly Pattern in Stock Returns: Cash Versus Futures: A Note," *Journal of Finance,* 40:583–588.

Day, T., and Lewis, C. (1988, Spring): "The Behavior of the Volatility Implicit in the Prices of Stock Index Options," *Journal of Financial Economics,* 22:103–122.

Dickinson, A., and Peterson, D. (1989, November): "Seasonality in the Option Market," *The Financial Review,* 24:529–540.

Dyl, E., and Maberly, E. (1986, December): "The Weekly Pattern in Stock Index Futures: A Further Note," *Journal of Finance,* 41:1149–1152.

Flannery, M., and Protopapadakis, A. (1988, June): "From T-Bills to Common Stocks: Investigating the Generality of Intra-Week Return Seasonality," *Journal of Finance,* 43:431–450.

French, K. (1980, November): "Stock Returns and the Weekend Effect," *Journal of Financial Economics,* 8:55–69.

Harvey, C., and Whaley, R. (1991): "Market Volatility Prediction and the Efficiency of the S&P 100 Index Option Market," Working Paper, Duke University, Durham, NC.

Harvey, C., and Whaley, R. (1992, April): "Dividends and S&P 100 Index Option Valuation," *The Journal of Futures Markets,* 12:123–137.

Keim D. (1983, June): "Size-Related Anomalies and Stock Return Seasonality: Further Empirical Evidence," *Journal of Financial Economics,* 12:13–32.

Manaster, S., and Koehler, G. (1982, March): "The Calculation of Implied Variances from the Black–Scholes Model: A Note," *Journal of Finance,* 37:227–230.

Merton, R. (1973, Spring): "Theory of Rational Option Pricing," *The Bell Journal of Economics and Management Science,* 4:573–614.

Reinganum, M. (1983, June): "The Anomalous Stock Market Behavior of Small Firms in January: Empirical Tests for Tax-Loss Selling Effects," *Journal of Financial Economics,* 12:89–104.

White, H. (1980): "A Heteroscedasticity-consistent Covariance Matrix Estimator and a Direct Test for Heteroscedasticity," *Econometrica,* 48:817–838.