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Seasonality in Market Risk

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INTRODUCTION

The seasonality of common stock returns has received considerable attention in finance literature. Officer (1975), Rozeff and Kinney (1976), Gultekin and Gultekin (1983), Tinic and West (1984), and Aggarwal and Rivoli (1989) have studied the U.S. and other countries and found that common stock returns in January are generally higher than in other months. Banz (1981) and Reinganum (1981) have observed abnormally high returns on small firm stocks, and Keim (1983) determined that a significant portion of these abnormal returns occurs during the first few days of January. Amihud and Mendelson (1986) suggest, however, that any "size effect" may be a consequence of a spread effect, with firm size serving as proxy for liquidity. They argue that, rather than indicating an "anomaly" or market inefficiency, the return-spread relation represents a rational response by an efficient market to the existence of the spread.

Tax-induced seasonality in stock prices has been studied by Wachtel (1942), Branch (1977), and Dyl (1977). Roll (1982) and Reinganum (1983) link the January effect to the tax-loss selling at the end of the year. However, Brown, Keim, Kleidon, and Marsh (1983), and Gultekin and Gultekin (1983) have found empirical evidence against the tax-loss selling hypothesis in Australia where tax laws are similar to those in the U.S.A. Berges, McConnell, and Schlarbaum (1984) determined that the January effect existed in Canada prior to 1972 even though Canada had no capital gains tax before 1972. Although there is no capital gains tax in Japan, Kato and Schallheim (1985) found that the January effect also exists in the Japanese stock market.

Seasonality raises serious questions about the validity of the Capital Asset Pricing Model (CAPM) as a viable model to explain the pricing of risky assets. In their two-parameter CAPM tests, Tinic and West (1984) found that January not only has a higher risk premium than other months, it is the only month that shows a consistently positive, statistically significant relationship between expected return and risk. They determined that when data for January are withdrawn from the sample, the estimates of risk premiums are not significantly different from zero.

The objective of this study is to seek a possible explanation for the seasonality in common stock returns. The authors will test the hypothesis that expected return and risk are seasonally positively and significantly related and that seasonal variation in stock returns is the result of seasonal variation in the value of the CAPM beta.

RISK-RETURN RELATIONSHIP

The implications of the two-parameter CAPM for expected returns derive from the risk-return relationship of the following equation:

$$E(\tilde{R}_i) = E(\tilde{R}_o) + [E(\tilde{R}_m) - E(\tilde{R}_o)]\,\beta_i \qquad (1)$$

where $E(\tilde{R}_i)$ is the expected return on security i, $E(\tilde{R}_o)$ is the expected return on a riskless security, $E(\tilde{R}_m)$ is the expected return on the market portfolio, and β_i is the market risk of security i measured by

$$\beta_i = COV(\tilde{R}_i,\tilde{R}_m)/\sigma^2(\tilde{R}_m) \qquad (2)$$

Although they undertook no empirical tests, Rozeff and Kinney (1976) first mentioned the possibility of the existence of seasonal betas. If one assumes that there is seasonality in the risk-return relationship and that there exists s linear regressions of s strata corresponding to distinct "seasons," then equations (1) and (2) can be restated as follows:

$$E(\bar{R}_{is}) = E(\bar{R}_{os}) + [E(\bar{R}_{ms}) - E(\bar{R}_{os})]\, \beta_{is} \tag{3}$$

where,

$$\beta_{is} = COV(\bar{R}_{is}, \bar{R}_{ms})/\sigma^2(\bar{R}_{ms}) \tag{4}$$

If the regression coefficients vary by stratum, then a separate regression estimate of β_{is} can be computed for each stratum. Rozeff and Kinney (1976) argued that a weighted average of β_{is} computed for all strata would be a more efficient estimate of β_i than the usual least square estimate.

Test Methodology

Seasonal individual security betas can be computed with the following time-series regression model:

$$R_{ist} = \alpha_{ost} + \hat{\beta}_{ist} R_{mst} + e_{ist} \tag{5}$$

where R_{ist} are the seasonal daily returns on common stock i in time period t, and R_{mst} are the seasonal daily S&P 500 Composite Index returns in time period t.

Seasonal risk-return relationship can be empirically tested by using the following cross-sectional regression model:

$$R_{ist} = \hat{\tau}_{ost} + \hat{\tau}_{st} \hat{\beta}_{ist} + \hat{\varepsilon}_{ist} \tag{6}$$

A positive and statistically significant cross-sectional regression coefficient $\hat{\tau}_{st}$ would indicate that the seasonal market-risk measure $\hat{\beta}_{ist}$ can explain cross-sectional variation in seasonal security returns, R_{ist}.

The testing of the two-parameter CAPM presents unavoidable "errors-in-the-variables" problem (Fama and MacBeth, 1973). The expected return-risk equation (3)is in terms of the true values of the relative risk measure β_{is}. However, in the cross-sectional regression model (6), the estimates of beta, $\hat{\beta}_{ist}$, obtained with the equation (5) must be used.

Blume (1970) showed that for any portfolio p with weights x_{ip}, the portfolio beta can be calculated as follows:

$$\hat{\beta}_p = \hat{COV}(\bar{R}_p, \bar{R}_m)/\hat{\sigma}^2(\bar{R}_m)$$

$$= \sum_i x_{ip} \hat{COV}(\bar{R}_i, \bar{R}_m)/\hat{\sigma}^2(\bar{R}_m) = \sum_i x_{ip} \hat{\beta}_i \tag{7}$$

If the errors in the $\hat{\beta}_i$ are less than perfectly and positively correlated, the $\hat{\beta}_p$ can be a better estimate of the true market risk than the individual security betas. Therefore, the empirical test model (6) can be restated as follows:

$$R_{pst} = \hat{\tau}_{ost} + \hat{\tau}_{st} \hat{\beta}_{pst} + \hat{\varepsilon}_{pst} \tag{8}$$

Although the portfolio approach alleviates the "errors-in-the-variables" problem, it can result in what is known as "the regression phenomenon" (Fama and MacBeth, 1973). Since in a cross-section of $\hat{\beta}_{is}$ high observed betas tend to be greater than the true betas and low observed betas tend to be smaller than the true betas, forming portfolios on the basis of ranked $\hat{\beta}_{is}$ values for individual securities causes bunching of positive and negative sampling errors within portfolios. Portfolios with large estimated betas would overstate the true beta, and portfolios with small estimated betas would understate the true beta.

"The regression phenomenon" can be alleviated by forming portfolios with ranked $\hat{\beta}_{is}$ computed with data for a given time period and by using these portfolios in the empirical risk-return relationship tests of a subsequent time period. With the returns data of the subsequent period as the dependent variable, errors in the individual security betas estimated with the data of the previous period become random across securities within each portfolio and the effect of "the regression phenomenon" can be minimized. Therefore, the cross-sectional empirical test regression model (8) can be restated as follows:

$$R_{pst} = \hat{\tau}_{ost} + \hat{\tau}_{st}\hat{\beta}_{pst-1} + \hat{\varepsilon}_{pst} \tag{9}$$

Data

The data used in the analysis were drawn from the CRSP tapes for the 1977-1988 time period. Daily common stock returns data were used to obtain the individual stock betas. The Standard and Poor's Composite Index daily returns data were used as a surrogate market index in the beta regressions.

The criterion used for inclusion of stocks in the research sample was that they must have no missing returns data during the 12-year period studied. Our final research sample consisted of 446 stocks with no missing daily returns data in the 1977-1988 time period.

Common stock betas are commonly computed with year-round returns data for a time period of five years or shorter. In our study, along with conventional stock betas, we have also computed monthly seasonal stock betas. Since monthly stock betas are based on daily returns data within each month, this results in a significant loss of returns information in beta calculations. Therefore, a six-year time period was used in our monthly beta calculations so that daily returns information would be available for each stock for a six-month period, e.g., six Januaries, six Februaries, six Marches, etc. The beta estimates for the stocks were obtained with data for the 1977-1982 time period, and they were used to form the portfolios for the risk-return relationship empirical tests of the 1983-1988 time period.

Beta Calculations

A conventional beta was computed for each of the 446 stocks in the sample by regressing the daily returns data of the stock against the S&P Composite Index daily returns data for the 1977-1982 period. The conventional stock betas were used with the monthly stock betas to determine which beta can explain seasonal cross-sectional variation in common stock returns better.

Monthly betas were computed for all 12 months for each stock by using the regression model (5). For example, a stock's January beta was computed by regressing the January daily returns of the stock against the January S&P Composite Index daily returns in the 1977-1982 time period. A total of 5,352 monthly betas were computed for the 446 stocks in the sample. These betas were used to form monthly stock portfolios to test the statistical significance of the seasonal risk-return relationship with the regression model (9) in the 1983-1988 time period.

Seasonality Tests

In previous studies, the term "seasonality" has been used to imply that there are statistically significant differences in the mean stock returns across the calendar months (Gultekin and Gultekin, 1983). Therefore, the existence of seasonality can be determined by testing the hypothesis that the 12 months have identical mean returns.

In order to determine whether conventional beta fails to explain seasonality in stock returns and whether seasonal betas can better explain cross-sectional variation in seasonal stock returns, we must first determine if there is seasonality in the stock returns in the time period studied. Therefore, we applied both parametric and non-parametric ANOVA tests to the daily returns data of the 1983-1988 period to test the null hypothesis that:

$$H_o: \mu_1 = \mu_2 = \ldots\ldots\ldots\ldots = \mu_{12} \qquad (10)$$

where μ is the mean daily returns of the month. Rejection of the null hypothesis would imply that there is seasonality in stock returns in the time period studied.

Monthly mean daily returns, the standard deviation of daily returns in each month, and the ANOVA statistics are presented in Table 1. Our ANOVA test statistics show that the null hypothesis indicating that monthly mean returns are equal is rejected at the 7.7 percent significance level with the parametric tests and at the 6.07 percent significance level with the non-parametric tests.

Table 1
Mean Returns by Month and ANOVA Tests: 1983-1988

Month	Mean Daily Return	Standard Deviation
January	.0025	.0098
February	.0017	.0069
March	.0011	.0062
April	.0002	.0078
May	.0008	.0069
June	.0014	.0059
July	-.0004	.0067
August	.0013	.0069
September	-.0005	.0072
October	-.0012	.0198
November	.0005	.0079
December	.0011	.0079

Parametric ANOVA Tests

F-Ratio = 1.6597 Significance Level = 0.077

Most Unique Months:	LSD Test:	January and October (5% sign. level)
	Duncan Test :	January and October (5% sign. level)

Non-Parametric ANOVA Test (Kruskal-Wallis)

Chi-Square = 19.022 Significance Level = 0.0607

Our results confirm the presence of the January effect found in previous studies. January has the highest mean daily returns during the 1983-1988 time period. The LSD and Duncan tests show that January and October are the only two unique months that are significantly different at the five percent level from other months and from each other.

Since October data include the stock market crash of 1987, the mean daily returns of October is the lowest and the standard deviation of October daily returns is the highest of all 12 months. January has the second highest standard deviation of daily returns. The stock market crash of 1987 was followed by an extended period of excessive stock market volatility in 1987 and 1988. Since, according to the market model, higher relative volatility in individual stock returns should be coupled with higher average returns, we also included this volatile period in our analysis to test the seasonal validity of the market model.

Conventional Betas vs. Seasonal Betas: Empirical Tests

Our objective is to determine whether conventional betas or monthly betas can explain monthly stock returns better in the 1983-1988 time period. For this purpose, we first sorted the conventional and monthly betas of the 446 stocks in our sample computed with data for the 1977-1982 time period and formed 15 portfolios. With the exception of two portfolios with the smallest betas and two portfolios with the largest betas that contain 29 securities each, all the other 11 portfolios in the middle contain 30 securities each. The average beta levels of the conventional and monthly beta portfolios are presented in Table 2.

Table 2

Portfolio Averages with Conventional and Monthly Betas: 1977-1982

Port No	Number of Sec	Conv. Betas	Jan. Betas	Feb. Betas	March Betas	April Betas	May Betas
1	29	0.187	0.052	-0.043	0.100	-0.019	0.039
2	29	0.270	0.268	0.140	0.256	0.179	0.228
3	30	0.361	0.348	0.226	0.339	0.262	0.326
4	30	0.457	0.426	0.312	0.411	0.351	0.392
5	30	0.551	0.505	0.392	0.477	0.439	0.470
6	30	0.632	0.603	0.480	0.577	0.538	0.555
7	30	0.692	0.709	0.559	0.672	0.645	0.632
8	30	0.753	0.793	0.623	0.749	0.733	0.724
9	30	0.835	0.879	0.709	0.845	0.831	0.803
10	30	0.931	0.967	0.796	0.931	0.925	0.879
11	30	1.000	1.093	0.898	1.029	1.034	0.981
12	30	1.076	1.227	1.005	1.150	1.155	1.086
13	30	1.196	1.400	1.149	1.295	1.299	1.175
14	29	1.362	1.581	1.334	1.491	1.463	1.341
15	29	1.625	1.893	1.723	1.982	1.737	1.824
Average Beta:		0.795	0.850	0.687	0.820	0.771	0.764

TABLE 2 *(continued)*

PORTFOLIO AVERAGES WITH CONVENTIONAL AND MONTHLY BETAS: 1977-1982

Port No	June Betas	July Betas	Aug. Betas	Sept. Betas	Oct. Betas	Nov. Betas	Dec. Betas
1	-0.009	0.026	0.105	0.063	0.214	0.053	0.084
2	0.181	0.172	0.274	0.213	0.343	0.204	0.197
3	0.274	0.279	0.365	0.330	0.441	0.282	0.274
4	0.366	0.360	0.442	0.439	0.532	0.384	0.353
5	0.438	0.445	0.487	0.543	0.607	0.478	0.454
6	0.506	0.531	0.555	0.621	0.706	0.566	0.535
7	0.572	0.624	0.633	0.705	0.804	0.662	0.628
8	0.651	0.699	0.692	0.798	0.869	0.753	0.749
9	0.752	0.808	0.766	0.856	0.933	0.849	0.827
10	0.840	0.926	0.850	0.944	1.014	0.933	0.906
11	0.938	1.028	0.917	1.040	1.091	1.026	0.994
12	1.046	1.140	0.998	1.136	1.206	1.124	1.105
13	1.185	1.271	1.114	1.285	1.320	1.250	1.210
14	1.414	1.426	1.273	1.467	1.455	1.423	1.379
15	1.782	1.813	1.594	1.871	1.791	1.868	1.816
Aver:	0.729	0.770	0.738	0.821	0.888	0.790	0.767

The two months with the highest average beta levels appear to be January and October. A high-average beta level for a given month indicates that in a bear market the average returns level of that month would tend to be lower than those of the other months, and in a bull market the average returns level of that month would tend to be higher than those of the other months. The month with the lowest average beta level appears to be February. A low average beta level for a given month indicates that the average returns level of that month would not fluctuate as much as the market.

To test the statistical significance of the relationship between monthly stock returns and the market risk as measured by the conventional beta, we regressed the average monthly returns (R_p) of the 15 conventional beta portfolios in the 1983-1988 time period against the average betas (β_p) of the portfolios. The results are presented in Table 3. Our regression statistics indicate a positive and statistically significant relationship only in January and February. The regression coefficients have statistically significant negative signs for July, September, October, and November. These results show that the conventional beta fails to explain seasonal stock returns.

TABLE 3

MONTHLY RISK-RETURN REGRESSIONS WITH CONVENTIONAL BETAS: 1983-1988

Month	Regression Equation	Sign. Level	R-Square
January	$R_p = .0017 + .0010\ ß_p$	0.0002	0.539
February	$R_p = .0011 + .0009\ ß_p$	0.009	0.420
March	$R_p = .0007 + .0004\ ß_p$	0.103	0.191
April	$R_p = -.0001 + .0004\ ß_p$	0.122	0.174
May	$R_p = .0010 - .0003\ ß_p$	0.093	0.202
June	$R_p = .0017 - .0003\ ß_p$	0.263	0.095
July	$R_p = .0005 - .0011\ ß_p$	0.0001	0.807
August	$R_p = .0010 + .0004\ ß_p$	0.141	0.159
September	$R_p = .0002 + .0009\ ß_p$	0.001	0.570
October	$R_p = .0012 - .0029\ ß_p$	0.0001	0.842
November	$R_p = .0008 - .0003\ ß_p$	0.034	0.303
December	$R_p = .0007 + .0005\ ß_p$	0.097	0.198

To determine whether monthly betas can better explain monthly stock returns, we also ran regressions with the average betas of the 15 monthly beta portfolios as the independent variable and the average returns of the portfolios in the 1983-1988 time period as the dependent variable. The test statistics are presented in Table 4. The regressions with the monthly betas indicate a statistically significant, positive risk-return relationship in January, March, and April but a statistically significant, negative risk-return relationship in July, September, October, and November. Use of seasonal betas does not appear to provide a better explanation for the hypothesized positive relationship between the market risk and security returns.

TABLE 4

MONTHLY RISK-RETURN REGRESSIONS WITH MONTHLY BETAS: 1983-1988

Month	Regression Equation	Sign. Level	R-Square
January	$R_p = .0018 + .0008\ ß_p$	0.0002	0.656
February	$R_p = .0014 + .0004\ ß_p$	0.172	0.139
March	$R_p = .0006 + .0005\ ß_p$	0.004	0.482
April	$R_p = -.0002 + .0005\ ß_p$	0.009	0.422
May	$R_p = .0009 - .0002\ ß_p$	0.338	0.071
June	$R_p = .0017 - .0003\ ß_p$	0.118	0.178
July	$R_p = .0002 - .0009\ ß_p$	0.0001	0.781
August	$R_p = .0011 + .0003\ ß_p$	0.135	0.164
September	$R_p = .00004 - .0006\ ß_p$	0.001	0.613
October	$R_p = .0012 - .0027\ ß_p$	0.001	0.911
November	$R_p = .0007 - .0002\ ß_p$	0.284	0.088
December	$R_p = .0008 + .0004\ ß_p$	0.082	0.215

In the empirical tests presented in Tables 3 and 4, monthly average returns were calculated as an average for the 1983-1988 time period. In the empirical tests that follow, effects are examined of betas calculated with data for the 1977-1982 time period on the monthly average returns of only 1983.

Average monthly returns of the 15 conventional beta portfolios in 1983 were regresssed against the average betas of these portfolios. The results are presented in Table 5. The risk-return relationship appears to be positive and statistically significant in January, May, and June but negative and statistically significant in July, September, and October.

TABLE 5

MONTHLY RISK-RETURN REGRESSIONS WITH CONVENTIONAL BETAS: 1983

Month	Regression Equation	Sign. Level	R-Square
January	$R_p = .0004 + .0024\ ß_p$	0.0002	0.658
February	$R_p = .0023 + .00005\ ß_p$	0.928	0.001
March	$R_p = .0016 + .0006\ ß_p$	0.489	0.038
April	$R_p = .0024 + .0011\ ß_p$	0.108	0.186
May	$R_p = .0002 + .0022\ ß_p$	0.0001	0.687
June	$R_p = -.0006 + .0028\ ß_p$	0.001	0.613
July	$R_p = .0010 - .0021\ ß_p$	0.0002	0.677
August	$R_p = -.0003 - .00001\ ß_p$	0.981	0.000
September	$R_p = .0024 - .0014\ ß_p$	0.003	0.514
October	$R_p = .0021 - .0044\ ß_p$	0.0001	0.856
November	$R_p = .0012 + .0012\ ß_p$	0.103	0.191
December	$R_p = -.0010 + .0003\ ß_p$	0.545	0.029

Average monthly returns of the 15 monthly beta portfolios in 1983 were then regressed against the average betas of these portfolios. The results are presented in Table 6. The relationship between the monthly betas and the monthly returns is statistically significant and positive in January, April, May, and June but statistically significant and negative in July, September, and October[1].

TABLE 6

MONTHLY RISK-RETURN REGRESSIONS WITH MONTHLY BETAS: 1983

Month	Regression Equation	Sign. Level	R-Square
January	$R_p = .0010 + .0016\, \beta_p$	0.002	0.551
February	$R_p = .0023 + .00001\, \beta_p$	0.990	0.000
March	$R_p = .0014 + .0007\, \beta_p$	0.123	0.174
April	$R_p = .0024 + .0011\, \beta_p$	0.016	0.372
May	$R_p = .0009 + .0013\, \beta_p$	0.010	0.408
June	$R_p = .0005 + .0016\, \beta_p$	0.005	0.468
July	$R_p = .0007 - .0019\, \beta_p$	0.0001	0.721
August	$R_p = -.0005 + .0002\, \beta_p$	0.582	0.024
September	$R_p = .0025 - .0015\, \beta_p$	0.003	0.496
October	$R_p = .0025 - .0044\, \beta_p$	0.0001	0.804
November	$R_p = .0014 + .0009\, \beta_p$	0.117	0.178
December	$R_p = -.0010 + .0002\, \beta_p$	0.450	0.045

SUMMARY AND CONCLUSIONS

Seasonality raises serious questions about the validity of the CAPM as a viable model to explain the pricing of risky assets. Previous studies have shown that the conventional CAPM beta fails to explain seasonal variation in security returns. We have undertaken this study with a hope to show that seasonal betas may provide a better explanation for seasonal variation in security returns.

The possibility of the existence of seasonal betas was first mentioned by Rozeff and Kinney (1976); however, neither Rozeff and Kinney nor others have tested seasonal risk-return relationship with seasonal betas. In this study, we have tested this relationship by using both the conventional beta and monthly betas.

Our findings indicate that seasonal betas do not provide a better explanation for seasonal variation in stock returns. The basic premise of the market model is that the covariance of the returns on a security with the returns on the market portfolio is the main determinant of the expected rate of return on that security. If this is correct, then within the seasonal framework one would expect securities with higher seasonal returns to have higher seasonal betas and securities with lower seasonal returns to have lower seasonal betas. This does not, however, appear to be the case. The risk-return relationship appears to be positive and statistically significant in several months but statistically significant and negative in several other months. For most months, the relationship is not statistically significant using either the conventional beta or monthly betas. Our empirical findings provide new empirical evidence that the CAPM cannot explain seasonality in stock returns.

Since this study covers a relatively short time period, we have used daily data in our monthly beta calculations; however, there is substantial "noise" in daily data. Future research covering a longer time period with weekly data may find a significant positive relationship between monthly betas and monthly returns. Further research, using the type of methodology employed in Amihud and Mendelson (1986), may also be carried out to test the relationship between liquidity and seasonal market risk.

NOTES

[1]Assuming that the 1977-1982 time period used in our beta calculations may be too long, we also computed conventional and monthly betas for only two years with data for the 1983-1984 time period and used them in the risk-return seasonality tests of 1985. Like the results above, our findings with a shorter time period did not reveal a meaningful seasonal risk-return relationship. Although the parametric and non-parametric ANOVA tests indicated the presence of seasonality in 1985 stock returns, neither the conventional nor monthly betas could explain this seasonality.

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