Dividends and Market Efficiency: A Multi-Index Arbitrage Investment Strategy*

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Abstract

This paper employs both a multi-index model and linear programming to create a short and long portfolio of securities that have identical ex-post risk levels. While the two portfolios have identical ex-post risk, the long portfolio is composed of stocks with high dividend yields and the short portfolio is composed of stocks with low dividend yields. By shorting the low dividend yield portfolio and purchasing the high dividend yield portfolio, we create a zero investment portfolio with identical risk patterns. We then examine whether investors can earn an abnormal return on this *Investment Strategy* in a subsequent testing period. This paper adds to the dividend literature in three primary areas. First, it provides a more powerful and robust model for analyzing the relationship between dividends and stock returns than single-index model. Second, it helps resolve the dividend relevancy question by rejecting the *Dividends Increase Returns Theory*. Third, we find that our investment strategy provides ex-ante information for investors to earn an abnormal return that does not support market efficiency.

Introduction

The relationship between stock returns and dividend policies is a puzzle that remains unsolved after over thirty years of theoretical modeling and empirical testing. The unresolved controversy is whether dividends and dividend policies affect the value of the firm. The theoretical models developed to date give conflicting effects. The studies of Miller and Modigliani (1961) and Miller and Scholes (1978) conclude that dividend policies are irrelevant. Conversely, the studies of Walter (1956), Lintner (1956), Farrar and Selwyn (1967), Bhattacharya (1979), and Miller and Rock (1985) conclude that dividend policies are relevant. Therefore, empirical research must determine which theoretical models best explain the corporate market.

The first empirical issue that researchers have analyzed is how dividend changes affect stock returns. Although Watts (1973) finds no significant positive (negative) returns associated with dividend increases (decreases), most later empirical studies[1] using event study methodology conclude that dividend increases (decreases) result in increased (decreased) stock returns.

The second empirical issue deals with dividend levels (or dividend yields) and how they affect stock returns. Tests by Watts (1973) and Black and Scholes (1974) conclude that dividend yields are irrelevant because they find that there is no relationship between stock returns and dividend yields. Conversely, later studies by Stone and Bartter (1979) and Litzenberger and Ramaswamy (1979) conclude that dividend yields are relevant because they find a significant positive relationship between stock returns and dividend yields. Thus, these latter studies support the *Dividends Increase Returns Theory* and that dividend yield is an omitted variable in the Capital Asset Pricing Model (CAPM). In summary, the results of these four studies are ambiguous and conflicting.

This paper uses a newer and more robust methodology to analyze dividend yields and to determine whether dividends increase returns. A linear program and a multi-index model are used to form an *Investment Strategy*[2] that is subsequently used to analyze the relationship between dividend yields and stock returns. The application of a linear program and a multi-index model contributes to the dividend literature by meeting our three major objectives:

* The multi-index model accounts for much more variance of stock returns than the single-index market model. By controlling for different and more sources of risk, the power of the tests are much stronger than the earlier studies.

* The increased power permits the testing of the relationship between dividend yields and stock returns, an issue that has previously been subject to ambiguous results and conflicting conclusions.

* The linear program and data from the multi-index model permit an *Investment Strategy* that has implications for market efficiency. To preclude arbitrage, the return on the *Investment Strategy* should not be significantly different from zero.

The rest of the paper is as follows. The next section discusses the methodology and estimation procedures. Following that are the empirical results and contribution to the dividend literature. Finally, the conclusion summarizes the paper.

Methodology and Estimation Procedures

The capital asset pricing model (CAPM) has been used extensively to study dividend issues. Often, the model is slightly modified to include a dividend variable and/or to exclude the risk-free rate of return.[3] Roll and Ross (1980) and Hughes (1982) are two early studies that support the idea that multi-index model can explain a greater portion of the variance of stock returns in a time-series regression than the CAPM. These studies show that time-series specification with around five indexes can explain over fifty percent of the variance of stock returns in a portfolio. In contrast, Ehrhardt (1991) finds that the CAPM explains around twenty-nine percent. These studies suggest that the CAPM may not sufficiently explain the variance of stock returns in a time-series specification and that a multi-index model may be both more appropriate and more powerful in explaining stock returns.

Both Roll and Ross, and Hughes use factor analysis to statistically extract around five indexes that explain the variance. Neither study tried to identify or specify the indexes as the objective was to determine whether more indexes better explain the variance of stock returns. In addition, the multi-index model has been instrumental in explaining some test results obtained in the CAPM framework. For example, Chan, Chen, and Hsieh (1985) argue that a multi-index model can explain the small firm effect. The strengths of the multi-index model naturally lends itself to re-examining the topic of the relevance of dividends for this paper.

The multi-index model employed in this study assumes that an individual security's returns, excluding dividends, are a linear function of several indexes that can be written:

$$R_{it} = \alpha_i + \beta_{1i} I_{1t} + \beta_{2i} I_{2t} + \ldots + \beta_{Ki} I_{KT} + \varepsilon_{it} \quad (1)$$

where: R_{it} is monthly return based on price changes of firm i for period t, α_i is the intercept term for firm i; β_{ki} is the coefficient term on index k for firm i, I_{kt} is index score on index k for period t, and ε_{it} the error term.

Data and Methodology

This paper analyzes the twenty-five year period from 1965 to 1989. This period is segmented into twenty overlapping six-year periods.[4] Each six-year period is divided into a five-year estimation period and a one-year testing period. The first six-year period is 1965 to 1970 and the twentieth is 1984 to 1989. To be included in any six-year period, the firm must be listed on the NYSE and have no missing returns over the entire seventy-two month period. The number of firms for each testing period sample ranges from 929 (for the 1970 testing period) to 1202 (for the 1979 testing period). The mean number of firms for each testing period is around 1095 firms. The return data for this paper are obtained from the Center for Research in Security Prices (CRSP), Graduate School of Business, University of Chicago.

The predicted annual dividend yield for the sixth year is calculated for each sample firm similar to Bajaj and Vijh (1990). The CRSP monthly stock return without dividends is subtracted from the CRSP monthly stock return with dividends for each firm during the sixty-month estimation period. Then, an annual geometric mean dividend yield over the five-year estimation period is used as the predicted annual dividend yield for the testing period.

Next, the multi-index model parameters for each sample firm are estimated. To do this, principle component analysis is used to extract thirteen indexes and the associated sixty scores from fifty-two firms and their sixty monthly returns.[5] Ordinary least squares are then used to estimate the parameters for each firm in the sample via equation (1). More specifically, each firm's sixty monthly returns without dividends are regressed on the thirteen indexes. Additionally, we determine industry classification of the sample firms based on Sharpe (1982). All firms are classified into one of ten industries based on the two-digit Standard Industrial Classification (SIC) code reported by CRSP for each six-year period. The SIC code reported for the sixth year is used for each firm as the activity (and SIC code) of firms can change over time. It is important to note that the industry classification may play an important role in determining the dividend policy of the firm because of industry uniqueness.

The final step is to formulate an *Investment Strategy* that includes the purchase of a long portfolio of stocks and the sale of a short portfolio of stocks. The portfolio returns are assumed following the same process described earlier, such that:

$$R_{LT} = \sum_{i=1}^{N} W_{iL}\alpha_i + \sum_{i=1}^{N} W_{iL}\beta_{1i}I_{1t} + \ldots + \sum_{i=1}^{N} W_{iL}\beta_{13,1}I_{13,+} + \sum_{i=1}^{N} W_{iL}\varepsilon_{it} \quad (2)$$

$$R_{ST} = \sum_{i=1}^{N} W_{iS}\alpha_i + \sum_{i=1}^{N} W_{iS}\beta_{1i}I_{1t} + \ldots + \sum_{i=1}^{N} W_{iS}\beta_{13,1}I_{13,+} + \sum_{i=1}^{N} W_{iS}\varepsilon_{it} \quad (3)$$

where: R_{Lt} and R_{St} are the monthly returns without dividends on the long and short portfolios, respectively; α_i is the intercept term for firm i; β_{ki} is the coefficient term on index k for firm i; I_{kt} is index score on index k for period t; and ε_{it} is the specific error for firm i for period t.

The objective of the *Investment Strategy* is to maximize the dividend yield between the long and short portfolios subject to several conditions.

Condition 1: The investment in the long portfolio must equal the investment in the short portfolio so that this *Investment Strategy* has a zero net investment

Condition 2: To ensure diversification, two percent is the maximum amount that can be invested in any single stock.

Condition 3: To ensure diversification across at least four industries, thirty percent is the maximum amount that can be invested in any one of ten industries.

Condition 4: To minimize the variance of the *Investment Strategy*, the long and short portfolios should face similar risk as measured by estimated multi-index model parameters. This means that the weighted average of the parameters on the long portfolio must equal the weighted average of the parameters on the short portfolio. Thus, an economic shock via one of the indexes should not alter the price on the *Investment Strategy* because a shock that increases (decreases) the price on the long portfolio would be offset by a proportional decrease (increase) in price on the short portfolio.

However, one must look at the future returns of the *Investment Strategy* to determine if this methodology provides any ex-ante information beyond the ex-post information. Therefore, the return on the *Investment Strategy* over the testing period (following twelve months) are analyzed.

Empirical Results

The *average annualized dividend yield* over the twenty testing periods is 4.12%. The mean ex-post annualized return for each of the twenty estimation periods ranges from -8.69% to 24.78% with an overall average return over the twenty periods of 9.12%. The mean year-end capitalization of firms over our twenty-year testing period ranges from $577 million (1970) to $2,295 million (1989).[6]

The mean annual percentage for each industry over the twenty testing periods is quite interesting and is discussed below and reported in Table 1. As one would expect, the number of firms in an industry is not equal across the ten industries. The five industries with the smallest number of firms in our sample (*construction; energy; transportation; high-tech capital goods;* and *non-service consumer products*) account for less than 24% of the total firms in the full sample. The industry with the largest number of firms is *service consumer products* (31.5%) is greater than the five smallest industries combined. The standard deviation of the twenty percentages ranges from 0.3% (*energy*) to 2.7% (*service consumer products*). Thus, the number of firms in these industries has been very consistent over the twenty estimation periods.

An interesting situation occurs when the long and short portfolios are created and compared against our full sample. The long portfolio contains (as a percentage) nearly twice as many firms from *Finance* and *Utilities*. The finance and utility industries are both highly regulated industries as the *Finance* industry contains a large percentage of highly regulated financial service firms such as banks. This gain came primarily at the expense of the *Consumer Products* industry. The short portfolio contains relatively no *Utilities* and a much smaller percentage of firms from the *Finance* industry.

Explanatory Power

Three different techniques are employed to examine if the explanatory power of the multi-index model is significantly more powerful than the explanatory power of the single-index market model.[7] The first technique is a paired comparison t-test used to test the difference of the R^2s between the single-index market model and the multi-index model for the firms in each estimation period. The null hypothesis of the first technique is the explanatory power of the multi-index model is not significantly greater than that of the single-index market model. The one-tailed paired comparison t-test statistics (Table 2) all exceed the 0.001 critical value of 3.090. Thus, we can strongly reject the null hypothesis for every estimation period.

The second technique is an analysis of the overall average R^2 of the twenty periods for both the single-index market model and the multi-index model. The average R^2 for the multi-index model over the twenty estimation periods is 0.54 versus 0.33 for the single-index market model. The third technique is an analysis of the variances of the R^2s for the single-index market model and the multi-index model for each of the twenty estimation periods. As reported in Table 2, the variance of the R^2s for the multi-index model is smaller than that of the single-index model for every estimation period except one. Additionally, the average variance over the twenty estimation periods for the multi-index model is 1.52 versus 1.86 for the single-index market model. Thus, these techniques also support that the explanatory power of the multi-index model is greater than that of the single-index market model.

These three analyses provide strong evidence that the multi-index model employed in this study is more powerful and robust than the single-index market model. Not only does the multi-index model have significantly more explanatory power of observed stock returns than the single-index market model, but the R^2s of the firms estimated with the multi-index model also have much less volatility than those of the single-index market model. Thus, employing the multi-index model, which controls for different and more sources of risk, to test the relationship of stock returns and dividend yields is both an innovative and more powerful methodology than those employed by Black and Scholes (1974) and Litzenberger and Ramaswamy (1979).

Dividend Theories

The *Dividends Increase Returns Theory* hypothesizes that the mean monthly return on the *Investment Strategy* over the twenty testing periods should be significantly greater than zero. In addition, the returns of the *Investment Strategy* will follow a binomial distribution with the proportion of positive returns significantly greater than zero. The first test is a one-tailed t-test conducted on the mean monthly return of the *Investment Strategy* over the 240 months. The mean monthly return is -0.0036 and the t-test statistic is negative which is the wrong sign to support the theory. Thus, the t-test fails to reject the null hypothesis that dividends do not increase returns at the ten percent significance level. The second test is a one-tailed binomial t-test conducted on the observed proportion of positive monthly returns on the *Investment Strategy* over the 240 months. The number of positive returns is 102 out of 240, so the observed proportion of positive returns is 0.425 and the binomial t-test statistic is -2.324 which does not exceed the ten percent critical value of 1.282 as reported in Table 3. Thus, the binomial t-test fails to reject the null hypothesis that dividends do not increase returns at the ten percent significance level.

In summary, both the t-test and the binomial t-test fail to reject the null hypothesis that dividends do not increase returns. Alternatively, the two tests fail to support: (i) that dividends increase returns; (ii) that the *Investment Strategy* can generate a return significantly greater than zero; (iii) that the returns of the *Investment Strategy* follow a binomial distribution with the proportion of positive returns significantly greater than fifty percent; or (iv) that there is a positive relationship between stock returns and dividend yields.

The *Dividends are Irrelevant Theory* hypothesizes that the mean monthly return of the *Investment Strategy* over the twenty testing periods should not be significantly different from zero. In addition, the returns of the *Investment Strategy* will follow a binomial distribution with the proportion of positive returns not significantly different from fifty percent. The first test is a two-tailed t-test conducted on the mean monthly return of the *Investment Strategy* over the 240 months. Again, the mean monthly return is -0.0036 and the t-test statistic is -1.852 which does not exceed the five percent critical value of -1.960 as reported in Table 3. Thus, the t-test fails to reject the null hypothesis that dividends are irrelevant at the five percent significance level. However, the t-test statistic of -1.852 does exceed the ten percent critical value of -1.645. It is concluded that at the ten percent significance level, the t-test rejects: (i) that dividends are irrelevant; (ii) that the *Investment Strategy* cannot generate a return significantly different from zero; and (iii) that there is no relationship between stock returns and dividend yields. The second test is a two-tailed binomial t-test conducted on the observed proportion of positive monthly returns on the *Investment Strategy* over the 240 months. The number of positive monthly returns is 102 out of 240, so the observed proportion of positive returns is 0.425 and the binomial t-test statistic is -2.324 which exceeds the five percent critical value of -1.960. Thus, the binomial t-test rejects the null hypothesis that dividends are irrelevant at the five percent significance level.

In summary, both the t-test and the binomial t-test reject the null hypothesis that dividends are irrelevant at the ten percent significance level. However, the two tests provide conflicting conclusions at the five percent significance level. However, the binomial t-test is a more robust test than the t-test because the binomial t-test does not require that the monthly returns follow a normal distribution. Additionally, it is important to note that the signs on the t-test and binomial t-test statistics are negative which supports the hypothesis that there is a negative relationship between stock returns and dividend yields. Furthermore, at the ten percent significance level, the t-test and binomial t-test fail to support market efficiency because the *Investment Strategy* provides ex-ante information for investors to earn returns significantly different from zero on a net zero dollar investment. However, for investors to profit, they must reverse the formulation of the *Investment Strategy.* Rather than buying long the high dividend stocks in the long portfolios, investors must sell short these stocks. Additionally, rather than selling short the low dividend stocks in the short portfolios, investors must buy long these stocks. Failure of market efficiency in this situation is important. This result may be simply a market anomaly due to the specific period or data set used in this empirical examination and the somewhat ambiguous results at the five percent significance level regarding our testing of the irrelevance of dividends. On the other hand, the result appears to provide the opportunity for investors to earn an abnormal excess return that is economically meaningful on a zero net investment portfolio.

One reason to explain the negative relationship between stock returns and dividend yields is the free cash flow theory of Jensen (1986). The payment of high dividend yields better aligns management decisions and stockholders interests. By paying high dividend yields, management signals better future investment policies. Conversely, management avoids signaling overinvestment policies. Perhaps, this is why investors may accept a lower return from high dividend firms versus low dividend firms. Another reason to explain the negative relationship between stock returns and dividend yields is that investors may wish to avoid transaction costs associated with rebalancing portfolios. Thus, these investors may prefer portfolios with high dividend yields at the expense of a lower return. An example would be large institutional investors such as pension funds who find it cheaper to receive large dividend payments that can be used to meet future cash outflows versus selling stocks and then rebalancing their portfolios. The same case applies to elderly investors and widows that rely on dividend income to meet current living expenses. By using dividend income, transaction costs associated with the sale of stocks and rebalancing of portfolios can be avoided.

Conclusion

This paper uses linear programming to create a short and long portfolio of securities that have identical ex-post risk levels. The appropriate risk factors were determined using principal component analysis combined with a multi-index model. The two portfolios by design are identical except that the long portfolio is composed of stocks with high dividend yields and the short portfolio is composed of stocks with low dividend yields. By shorting the portfolio of stocks with low dividend yields and purchasing the portfolio of stocks with high dividend yields allows us to create s zero *net investment portfolio*. This *Investment Strategy* then allows us to examine returns in a subsequent testing period to determine if investors can earn an abnormal return.

This paper adds to the dividend literature in three primary areas. First, it provides a more powerful and robust model for analyzing the relationship between dividends and stock returns than single-index model. Second, it resolves the dividend relevancy question by rejecting the *Dividends Increase Returns Theory.* Third, we find that our investment strategy provides ex-ante information for investors to earn an abnormal return that does not support market efficiency. However, this negative relationship between dividend yields and stock returns can be explained by the free cash flow theory and the high transaction costs of rebalancing portfolios.

Endnotes

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1. See Aharony and Swary (1980), Kwan (1981), Brickley (1983), Kalay and Loewenstein (1986), and Christie (1990).

2. The *Investment Strategy*, by construction, consists of a long portfolio of high dividend yield stocks and a short portfolio of low dividend yield stocks. In theory, the *Investment Strategy* has a net zero dollar investment.

3. Some studies that use either the CAPM or a modified version of the CAPM are: Watts (1973); Brennan (1970); Black and Scholes (1974); Stone and Bartter (1979); Litzenberger and Ramaswamy (1979, 1980); Aharony and Swary (1980); Kane, Lee, and Marcus (1984); Richardson, Sefcik, and Thompson (1986); Christie (1990); Bajij and Vijh (1990); and Lamoureux (1990).

4. The choice of estimation/holdout period is consistent with Black, Jensen, and Scholes (1972) and Stone and Bartter (1979). Both studies segment their time period into overlapping six-year periods with each six-year period divided into a sixty-month estimation period and a twelve-month testing period.

5. All the firms in the sample, denoted N, are sorted from the firm with the lowest return over the sixty-month period to the firm with the highest return. Firms with the same return are then sorted by their dividend yield over the sixty-month period. Then, approximately every nineteenth firm in the sample is selected to make up the fifty-two firm sample. Since principal components analysis requires that the correlation matrix be invertable, the number of firms selected must be less than the number of monthly stock returns or the correlation matrix is singular. Two other selection procedures are used and the results do not change significantly.

6. We determine the year-end capitalization (share price multiplied by the shares outstanding) at the end of the sixth year.

7. The following single-index market model is estimated over the five-year estimation period for each firm in each sample:

$$R_{it}=\alpha_i+\beta_i R_{mt}+\varepsilon_{it}$$

where α_i is the intercept term for firm i; β_i is the systematic risk faced by firm i; R_{it} and R_{mt} are the returns based on the price changes of firm i and the equal weighted NYSE market index, respectively, for month t; and ε_{it} is the error term.

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Table 1
Industry Investment Percentages of the Firms in the Long Portfolios, Short Portfolios, and the Sample Firms over the Twenty Testing Periods.

Industry Classification	Long Portfolios		Short Portfolios		Full Firm Sample	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
1. Basic Goods	10.4	5.9	9.7	5.7	11.0	1.3
2. Non Hi-Tech Capital Goods	8.0	3.8	8.7	2.7	10.0	0.6
3. Construction	4.4	4.4	3.5	2.8	4.2	0.4
4. Consumer Products	19.4	5.9	27.7	3.5	31.5	2.7
5. Energy	1.6	2.8	7.9	4.8	4.2	0.3
6. Finance	22.8	7.6	17.5	4.7	11.7	3.9
7. Transportation	5.7	5.5	8.0	3.6	5.7	0.7
8. Utilities	23.2	11.0	1.6	2.2	12.6	0.5
9. Hi-Tech Capital Goods	2.7	1.7	7.3	2.3	5.6	0.6
10. Non-Service Consumer Products	1.9	1.1	8.1	4.1	3.5	0.6

Table 2
Statistics on the Mean R^2s for the Single-Index Market Model and the Multi—Index Model for Each Estimation Period.

Estimation Period	Firms	Single-Index Model		Multi-Index Model		T-Test Statistics
		Mean R^2	Variance	Mean R^2	Variance	
1965 - 1969	929	0.296	.01354	0.501	.01470	55.341*
1966 - 1970	963	0.332	.01359	0.530	.01302	56.669*
1967 - 1971	997	0.344	.01388	0.526	.01268	59.018*
1968 - 1972	1021	0.329	.01489	0.514	.01482	64.443*
1969 - 1973	1071	0.366	.01811	0.557	.01437	56.721*
1970 - 1974	1113	0.357	.01610	0.562	.01315	65.934*
1971- 1975	1115	0.369	.02156	0.586	.01418	63.866*
1972 - 1976	1163	0.379	.02297	0.604	.01557	63.188*
1973 - 1977	1185	0.391	.02350	0.612	.01410	66.664*
1974 - 1978	1202	0.382	.02112	0.608	.01434	67.713*
1975 - 1979	1184	0.379	.02160	0.592	.01513	65.044*
1976 - 1980	1162	0.343	.01856	0.558	.01357	56.022*
1977 - 1981	1167	0.311	.01556	0.551	.01442	60.758*
1978 - 1982	1157	0.323	.01644	0.548	.01500	53.071*
1978 - 1983	1140	0.272	.01455	0.508	.01441	61.510*
1979 - 1984	1114	0.259	.01590	0.498	.01699	57.031*
1980 - 1985	1091	0.249	.01709	0.469	.01665	62.965*
1981 - 1986	1082	0.250	.02023	0.481	.01870	59.345*
1982 - 1987	1035	0.324	.02532	0.521	.01909	49.434*
1983 - 1988	1018	0.336	.02684	0.556	.01958	50.652*
Mean	1.095	0.329	.01857	0.544	.01522	

*Significant at the 1% level.

Table 3
Statistics on the Monthly Returns, with and without Dividends, of the Investment Strategy, and Long and Short Portfolios over the Twenty Testing Periods Using the Multi-index Model.

	Investment Strategy w/ Divs	*Investment Strategy* w/o Divs	Long Portfolio w/ Divs	Short Portfolio w/ Divs
Observations	240	240	240	240
Mean Monthly Return	-0.003562	-0.008918	0.011559	0.015121
Variance of Monthly Returns	0.000888	0.000881	0.002565	0.004289
Coefficient of Variation	8.366	3.328	4.382	4.331
T-test	-1.852**	-4.654*	3.536*	3577*
Mean Annualized Return	-0.0427	-0.1070	0.1387	0.1815
Minimum Monthly Return	-0.107164	-0.112487	-0.163654	-0.283135
Maximum Monthly Return	0.119480	0.113850	0.297609	0.312523
Proportion of Positive Monthly Returns	0.425	—	—	—
Binomial T-Test	.2.324*	—	—	—

*Significant at the 5% level. **Significant at the 10% level.