THE CAPITAL ASSET PRICING MODEL, TESTS OF PORTFOLIOS SELECTED FROM STOCKS WITH POOR PAST PERFORMANCE AND AN INVESTIGATION OF THE ABILITY OF DISCRIMINANT ANALYSIS TO DIFFERENTIATE PERFORMANCE

Dissertation for the Degree of Ph. D.

MICHIGAN STATE UNIVERSITY
WAYNE FAIRBURN

1975

This is to certify that the

thesis entitled

THE CAPITAL ASSET PRICING MODEL, TESTS OF PORTFOLIOS SELECTED FROM STOCKS WITH POOR PAST PERFORMANCE AND AND INVESTIGATION OF THE ABILITY OF DISCRIMINANT ANALYSIS TO DIFFERENTIATE PERFORMANCE

presented by

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has been accepted towards fulfillment of the requirements for

Ph.D. degree in Business - Finance

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Date 7/23/75

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ABSTRACT

THE CAPITAL ASSET PRICING MODEL, TESTS OF PORTFOLIOS SELECTED FROM STOCKS WITH POOR PAST PERFORMANCE AND AN INVESTIGATION OF THE ABILITY OF DISCRIMINANT ANALYSIS TO DIFFERENTIATE PERFORMANCE

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The purpose of this research was twofold. The first purpose was to test the Sharpe-Lintner capital asset pricing model (CAPM), on the sample of common stocks listed on the New York Stock Exchange which had the poorest price performance during various calendar years. The second purpose was to ascertain whether multiple discriminant analysis could predict future relative performance ranks of a similar sample of securities based upon a profile of their financial characteristics.

The initial sample for the CAPM tests consisted of those twenty common stocks which had experienced the greatest percentage price losses during each of the calendar years 1956 through 1967. Those firms without calendar year accounting periods as well as utilities, financial institutions, and transportation companies, were excluded from the initial sample.

The test of the CAPM entailed the comparison of realized one-year and three-year holding period returns (exclusive of cash dividends) subsequent to the year of poor price performance, with returns conditionally expected by the CAPM, given the market return over the holding

periods and given the historically calculated beta coefficients. Twelve portfolios with one-year holding periods and ten portfolios over three-year holding periods were tested.

The paired difference t-test of the null hypothesis that the average differences between realized returns and those conditionally expected by the CAPM was not significantly different from zero, was not rejected at the .05 level. The Sharpe-Lintner CAPM gave conditionally expected return predictions which over the ten year period tested did not differ on average from the realized returns. However, it was found that within individual one-year and three-year holding periods, large differences between realized and conditionally expected returns typically occurred.

The tests of the ability of discriminant analysis to differentiate investment performance involved using the same sample of firms as for the CAPM tests, selected in the same manner, but for the calendar years 1962 through 1971. The tests were divided into two parts. The first series of tests concerned the ability of the discriminant functions to correctly classify according to performance in nine-month and thirty-three month holding periods (beginning in April subsequent to each calendar year of poor price performance), a random holdout sample of firms from the same time period as that from which the discriminant functions were calculated. This test determined whether the discriminant functions could detect variable profile relationships which were stable within the same time period. Each discriminant function was constructed from a profile of fourteen representative financial characteristics.

The next series of tests evaluated the predictive ability of discriminant analysis by using the functions developed during the period 1962-1966 to classify firms from the later period 1967-1971 according to expected relative performance. The estimated performance rankings were compared with the actual performance rankings for this later period and correlated using the Spearman Rank Order Correlation Coefficient. The null hypothesis for both test series was that the correlation between actual and predicted performance ranks was less than or equal to zero and the alternative hypothesis that it was greater than zero. None of the tests rejected the null hypothesis. The results uniformly indicated that for the sample and time period tested, discriminant analysis possessed little ability to differentiate performance among securities either within the same time period or for future time periods as would be implied by the use of discriminant analysis for investment purposes.

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By

Wayne Fairburn

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Accounting and Financial Administration

1975

To Bea

ACKNOWLEDGMENTS

I wish to express deep and sincere appreciation to my dissertation committee members: Dr. Myles Delano, Dr. Alden Olson, and Dr. Dan Collins.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

Capital Market Theory

Due to the pioneering work of Markowitz[1] and to subsequent contributions by Sharpe,[2] Lintner,[3] Mossin,[4] Fama,[5] and others, modern capital market theory has become a widely accepted explanation of the equilibrium prices of capital assets under conditions of uncertainty. In recent years the investment community has become increasingly aware of the implications of capital market theory for investment practice.[6] For example, the widely used Value Line investment service includes beta coefficient data for most stocks listed on the New York Stock

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[1]Markowitz, Harry, "Portfolio Selection," Journal of Finance (March 1952), pp. 77-91.

[2]Sharpe, William F., "Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk," Journal of Finance (September 1964), pp. 425-442.

[3]Lintner, John, "The Valuation of Risk Assets and the Selection of Risky Investments in Stock Portfolios and Capital Budgeting," Review of Economics and Statistics (February 1965), pp. 13-17.

[4]Mossin, Jan, "Equilibrium in a Capital Asset Market," Econometrica (October 1966), pp. 768-783.

[5]Fama, Eugene F., "Risk, Return and Equilibrium: Some Clarifying Comments," Journal of Finance (March 1968), pp. 29-40.

[6]For example, refer to many articles in recent years appearing in the Financial Analysts Journal, a publication oriented toward the practicing financial analyst.

Exchange.

The capital asset pricing model (CAPM) in the Sharpe-Lintner form states three things: (1) that a portfolio or security's covariance of rate of return with that of the market is the appropriate measure of risk; (2) that the beta coefficient is a useful measure of this risk; and (3) that expected returns for a portfolio are proportional to the degree of risk as measured by the beta coefficient.[7] The CAPM assumes that investment decisions are based upon a trade off between the two parameters of risk and return. While the model is obviously a simplification of reality, it nevertheless may provide a useful means for explaining the process which determines security prices.[8]

In a test of the CAPM, Sharpe and Cooper have shown that, in general, average annual returns of low-risk portfolios tended to have lower average returns than high-risk portfolios.[9] The annual returns were generally consistent with the CAPM on average over the entire holding period (1931-1967), but conformance to the theory declined as the time period under study was shortened. The degree to which this

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[7]For a detailed exposition of the capital asset pricing model and the beta coefficient, see: William F. Sharpe, Portfolio Theory and Capital Market (New York: McGraw-Hill Book Co., 1970), or see: J. C. Francis, and S. H. Archer, Portfolio Analysis (Englewood Cliffs, N. J.: Prentice-Hall, Inc., 1971).

[8]For a more detailed summary of the explicit and implicit assumptions involved in the capital asset pricing model see Jensen, Michael C., "The Foundations and Current State of Capital Market Theory," in Studies in the Theory of Capital Markets, M. C. Jensen, ed. (New York Praeger Publishers Inc., 1972), p. 5.

[9]Sharpe, William F., and Guy M. Cooper, "Risk-Return Classes of New York Stock Exchange Common Stocks, 1931-1967," Financial Analysts Journal (March 1972).

occurred, however, was not specified. The portfolios making up each tested risk-return decile were also quite large, ranging from 47 to 99 securities each. The fact that firms which did not exist at the end of the period (but did exist prior to this time) were not included in the samples constituted a possible source of bias in the return calculations.

In a similar study of the Sharpe-Lintner form of the CAPM, Black, Jensen, and Scholes (BJS) found that the model was not completely adequate as a description of security returns since there was a tendency for high-beta portfolios to offer lower than expected returns and for low-beta portfolios to exhibit higher returns than expected.[10] They then proposed and tested an expanded version of the CAPM which expressed the return on a security as a linear function of both the market return and a portfolio whose covariance with the market return was zero.

Over the 35-year holding period of the BJS study extending from 1931 through 1965, the relationship between average excess monthly returns and the degree of systematic risk, as measured by the beta coefficient, was approximately linear. The same linear relationship also was found for the four equal nonoverlapping subperiods of 105 months duration. In the BJS study the portfolios tested were large, ranging in size from 58 to 109 securities each.

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[10] Black, Fisher, Michael C. Jensen, and Myron Scholes, "The Capital Asset Pricing Model: Some Empirical Tests," in Jensen, Studies in the Theory of Capital Markets.

Studies by both Blume[11] and Levy[12] have demonstrated that individual firms changed risk classes infrequently over time. For diversified portfolios, risk class levels were very stable since those securities which moved to higher risk classes tended to be counterbalanced by those moving to lower risk classes. Investors could it was argued, select portfolios from any desired utility-maximizing risk level by simply relying upon the historical beta levels of the component securities as unbiased estimators of the "true" portfolio beta. The weighted average beta of the selected portfolio would thus constitute an implicit forecast of future returns of the portfolio relative to market returns. For example, if the beta level for the selected portfolio were 1.5, then the portfolio's future returns should be 1.5 times the market return.

A study by Evans and Archer showed that the degree of unsystematic risk could be almost eliminated through diversification using a small number of issues, thus a large portfolio was deemed to be unnecessary.[13] In fact, a large portfolio required greater administrative effort as the number of securities grew beyond the necessary number (usually less than but seldom more than twenty stocks). After the initial study by Blume and the later Levy study, the usefulness of historical betas as proxies for their (unobservable) future values became a matter of great interest.

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[11] Blume, Marshall E., "On the Assessment of Risk," Journal of Finance (March 1971).

[12] Levy, Robert A., "On the Short-term Stationarity of Beta Coefficients," Financial Analysts Journal (November 1971).

[13] Evans, John L., and S. H. Archer, "Diversification and the Reduction of Dispersion: An Empirical Analysis," Journal of Finance (December 1968), pp. 761-769.

The practical implication of this reasoning was that the investor might want to select a utility-maximizing level of nondiversifiable or market risk (represented by the weighted average beta coefficient of the portfolio). He could diversify away most unsystematic risk (even a few securities would suffice), and then expect future returns proportional to the level of systematic risk taken.[14]

The proportional relationship between risk and return was demonstrated by the Sharpe and Cooper,[15] and the Black, Jensen, and Scholes[16] studies. These studies strongly affirmed the existence of a reward for bearing risk over the long run. While the proportional relationship between risk and return is reasonably stable over long time periods, little is known regarding this relationship over shorter time periods when small portfolios form the investment vehicle. Knowledge of whether the CAPM is a valid predictor of the returns to be derived from small portfolios over short holding periods is important for two reasons: First, adequate levels of diversification can be achieved with a small number of securities, and secondly, many investors do in fact invest for short holding periods.

Multiple Discriminant Analysis

In investment analysis the price of an equity security is frequently considered to represent the present value of future dividends.[17]

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[14]For example, this basic strategy is advocated by Francis, Jack, Investments: Analysis and Management (New York: McGraw-Hill Book Co., 1972), p. 590.

[15]Sharpe and Cooper, op. cit.

[16]Black, Jensen, and Scholes, op. cit.

[17]J. B. Williams, The Theory of Investment Value (Cambridge, Mass.: Harvard University Press, 1938).

When this approach is used, fundamental analysis determines a stock's "intrinsic" value by estimating future dividend streams and then discounting these by a rate dependent upon risk. Intrinsic value would next be compared with market price and a decision made as to whether the stock should be bought or sold short. Fundamental analysis assumes the market at times prices securities inefficiently. In such a case opportunities exist for the fundamental analyst to acquire underpriced issues which the market will subsequently reprice.

Numerous common stock investment strategies have been practiced both individually and in combination with one another.[18] The concept of market inefficiency, however, is perhaps most completely embodied in the "undervalued issue strategy," popular within the ranks of fundamentally oriented investors and analysts. Douglas Hayes provided a useful description of this strategy:[19]

> "But as a special strategy designed to obtain greater than average returns available on common stocks generally, it has come to be identified with a particular type of company emerging from a behavioral theory of the market. The behavioral theory is that the market tends to exaggerate the importance of unfavorable developments or perhaps the mere absence of a highly dynamic potential. By the same token it is held that the market also tends to overemphasize favorable factors. In short, the theory is the logical extension of the vogue theory, noted in connection with growth stocks, to an anti-vogue theory. The view is that prices of certain stocks may be unreasonably depressed because of an undue emphasis on the immediate past earnings performance or on some unfavorable information of a general sort.

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[18]For a discussion of other types of investment strategies such as trading, cyclical timing, buy-and-hold, etc., see: Hayes, Douglas A., Investments: Analysis and Management (New York: Macmillan Co., 1966), Second ed., Ch. 5.

[19]Ibid., pp. 77-78.

Substantial returns may well be obtained, it is argued, when and if it becomes clear that the adverse performance was indeed temporary or that the potential problems were not as catastrophic as was generally believed. Recognition of the improved situation may take time, but ultimately, it is held, the market price will reflect the improvement. Note that it is not growth that is anticipated, but only a reasonable recovery to former levels of earnings performance. Such a recovery should, it is argued, ultimately produce investment returns well in excess of the secular performance of the market as a whole. Moreover, because prices are depressed at the time of acquisition, dividend yields on cost are usually quite satisfactory if further reductions in the dividend rate do not subsequently take place."

Hayes further stated that the undervalued issue strategy would take a great deal of skill on the part of the investor and often considerable patience while waiting for the market to appropriately value the stock. The undervalued issue could also be quite risky because of the difficulty faced in distinguishing temporary from permanent adversity.

Support for the strategy of selecting inappropriately priced securities can be found in Graham, Dodd, and Cottle's classic work:[20]

"It is our thesis that the stocks of companies with disappointing showings usually sell lower than they should, for the same basic reason that stocks as a whole sell too low during periods of depression. The significance of the unfavorable conditions is exaggerated. If this view is correct, the "poorer issues will normally be undervalued in the market in relation to the better issues, with the possible exception of low-priced stocks as a whole, which attract a special sort of speculative interest. Broadly speaking, this generalization is valid.

Our view is based on the principle that in the majority of cases companies showing an unfavorable trend of earnings will reach a bottom at some time and that thereafter their earnings will fluctuate irregularly around some indicated average or normal base. The market price will usually

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[20] Graham, Benjamin, David L. Dodd, and Signey Cottle, Security Analysis Principles and Techniques (New York: McGraw-Hill Book Co., 1962), Fourth Ed., p. 696.

> have fallen well below the value indicated by the latter as well as by the asset-value factors. Consequently there is an undervaluation and a practical opportunity for profitable purchase.

Quantitative techniques may play an important role in aiding the process of security analysis and selection. Multiple discriminant analysis is one technique which is used in the field of Finance[21] which might be useful for security analysis. Edward Altman used multiple discriminant analysis successfully for the prediction of corporate bankruptcy. He said the following concerning possible applications of multiple discriminant analysis to investment problems:[22]

> The potentially useful applications of an accurate bankruptcy predictive model are not limited to internal considerations or to credit evaluation purposes. An efficient predictor of financial difficulties could also be a valuable technique for screening out undesirable investments. On the more optimistic side it appears that there are some very real opportunities for benefits. Since the model is basically predictive the analyst can utilize these predictions to recommend appropriate investment policy....
>
> While the above results are derived from an admittedly small sample of very special firms, the potential implications are of interest. If an individual already owns stock in a firm whose future appears dismal, according to the model, he should sell in order to avoid further price declines. The sale would

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[21]For example see such studies as J. E. Walter, "A Discriminant Function for Earnings Price Ratios of Large Industrial Corporations," Review of Economics and Statistics, vol. XLI (February 1959), pp. 44-52; K. V. Smith, Classification of Investment Securities Using MDA, Institute Paper #101 (Purdue University, Institute of Research in the Behavioral, Economic, and Management Sciences, 1965); Edward I. Altman, "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy," Journal of Finance, vol. XXIII (September 1968), pp. 589-609; W. T. Carlton and E. M. Lerner, "Statistical Credit Scoring of Municipal Bonds," Journal of Money, Credit, and Banking I (November, 1969); A. S. McCall and R. A. Eisenbeis, "Some Effects of Affiliations Among Mutual Savings and Commercial Banks," FDIC Working Paper No. 71-1, 1970; R. A. Eisenbeis, "A Study of the Delineation of Geographic Markets for Business Loans," Unpublished Ph.D. Dissertation, University of Wisconsin, 1971.

[22]Altman, p. 608.

> prevent further loss and provide capital for alternative investments. A different policy could be adopted by those aggressive investors looking for short-sale opportunities. An investor utilizing this strategy would have realized a 26 per cent gain on those listed securities eligible for short-sales in the original sample of bankrupt firms....

Keith Smith, discussing his successful application of multiple discriminant analysis to the classification of securities into specific investment grades stated, "In addition, it should be possible to extend the analysis to other types of investment, i.e., to search for variable profiles which characterize distinct investment opportunities and thereby enhance the portfolio selection process."[23]

Research Purpose

The purpose of this research was twofold. The first purpose was to test the Sharpe-Lintner capital asset pricing model on the sample of common stocks listed on the New York Stock Exchange which had the poorest past price performance during a calendar year. Small portfolios of less than 20 securities taken over relatively short holding periods of 1 and 3 years were tested to ascertain whether their performance during holding periods subsequent to the year of poor performance yielded returns consistent with those which would have been expected according to the Sharpe-Lintner CAPM, given the market performance during the same holding period. The second purpose of the research was to ascertain whether multiple discriminant analysis (MDA) could predict future relative performance ranks of securities based upon a profile of their financial characteristics. The results provided information relative to the potential usefulness of MDA as a tool for augmenting the

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[23] Smith, pp. 33-34.

security analysis process.

Outline of Tests

This research was limited to those common stocks which experienced the greatest percentage price declines during each of the calendar years 1956 through 1968 for the purpose of testing the CAPM, and for the years 1962 through 1971 for the MDA tests. Various subperiods from within these yearly groups were selected for the particular tests which are outlined below.

Capital Asset Pricing Model Tests

The test of the Sharpe-Lintner capital asset pricing model (CAPM) entailed the comparison of realized one-year and three-year holding period returns (exclusive of cash dividends) with returns conditionally expected by the CAPM given the market return over the same holding periods and the historically calculated beta. The initial sample consisted of the twenty common stocks which had experienced the greatest percentage price losses during each of the calendar years 1956 through 1967. Firms without calendar year accounting periods as well as utilities, financial corporations, and transportation companies, were excluded from the original sample.

The null hypothesis was that no significant different existed between the expected return (conditional upon the subsequent market return and the historical portfolio beta) and actual returns. The conditional expected portfolio return for time t was $E(R_{Pt}/b_p,R_{Mt})$ given the average historical portfolio beta, b_p, and the return of the market for time t, R_{Mt}. The null hypothesis tested was that the average difference, $\bar{D}$, between expected portfolio return, $E(R_{Pt})$, where

$$E(R_{Pt}) = b_P R_{Mt}$$

and actual portfolio return, R_{Pt}^{A}, for time t

$$D_t = R_{Pt}^{A} - E(R_{Pt}/b_P, R_{Mt})$$

was equal to zero. Where

$$\overline{D} = \frac{1}{n} \sum_{t=1}^{n} D_t$$

for the n holding periods. Thus the hypotheses were

$$H_0 : \overline{D} = 0$$

$$H_1 : \overline{D} \neq 0$$

The paired difference t-test was made at the .05 level of significance for both the twelve one-year holding period returns and the ten three-year returns.

Discriminant Analysis Tests

A set of tests was conducted to evaluate the ability of multiple discriminant analysis to differentiate the future performance of common stocks. A set of fourteen representative financial ratios was calculated for each of the securities from the sample. Utilizing discriminant analysis, the profile of financial measures was selected which appeared best able to separate those stocks displaying price increases from those suffering price declines (relative to the market) over the subsequent nine-month and thirty-three month holding periods. The financial ratios were taken at the end of the calendar year in which the stock had experienced the large percentage price decline. The nine and thirty-three month holding periods began three months after the previous year end when the ratios were calculated. This time lag was intended to represent the normal lapse of time from the end of a company's accounting period until the release of that information to the public.

Several tests were conducted to ascertain the ability of multiple discriminant analysis to differentiate the performance of common stocks on the basis of financial characteristics. The two major test categories are outlined below:

I. The first category of tests determined whether the selected profile of financial ratios could differentiate the performance of an independent sample of firms during the <u>same</u> time period as that in which the profile was selected. The ratio profile, or discriminant function, was selected using the stepwise multiple discriminant analysis method from the group of fourteen representative financial ratios. The independent samples were randomly withheld from the qualifying sample before the discriminant functions were computed. The independent samples were then ranked for future performance on the basis of their discriminant scores. The actual and predicted performance ranks were correlated and tested using the Spearman Rank Order Correlation Coefficient.

   Both nine-month and thirty-three-month holding periods were evaluated for firms having poor price performance during the calendar years 1962 through 1966. In addition to the tests discussed above, the firms within this same 1962 through 1966 sample period were dichotomized according to whether the market increased or decreased during the year of poor price performance. From these subgroups were taken random holdout samples whose performance ranks were predicted according to their discriminant scores. Again, the discriminant functions were calculated from the sample of firms which were not randomly withheld. Using the procedures discussed above for the non-dichotomized samples, the predicted and realized return ranks were correlated and tested with the Spearman Rank Order Correlation Coefficient. The null hypothesis was that no correlation existed between predicted and actual performance ranks in the subsequent nine- and thirty-three-month holding periods.

II. The next major category of tests determined whether discriminant functions, constructed to differentiate the subsequent nine and thirty-three-month performance of stocks with poor performance in the 1962 through 1966 period, could predict performance ranks of a similar sample of stocks taken from a later test period, 1967 through 1971, test. No random holdout samples were taken from the 1962 through 1966 sample prior to constructing these discriminant functions since the later test sample was independent of the sample from the earlier period. As was done for the previous category, the predicted and actual performance ranks were correlated and tested using the Spearman Test. Discriminant functions were also separately constructed and tested for both the group of years during which the market rose and for the other group of years in which the market fell.

CHAPTER II

LITERATURE REVIEW

This chapter is composed of three sections. Evidence bearing upon the validity of the Sharpe-Lintner capital asset pricing model is taken up first. Next, applications of discriminant analysis in Finance are surveyed, followed by evidence relating to the ex ante usefulness of financial ratios.

Sharpe-Lintner Model

The Sharpe-Lintner capital asset pricing model states that expected "excess" returns (above the riskless rate) on an asset are equal to the expected excess returns on a "market portfolio" times the systematic risk of the asset. The market portfolio consists of a market-value weighted proportional investment in every outstanding asset.

Jensen had this to say about empirical tests of the model:

> The Sharpe-Lintner asset pricing model has received widespread attention in the literature in the past five years. Therefore, it is surprising that there have been so few attempts at empirical verification of the model. Most of the early evidence bearing on the model did not represent direct tests but, rather, emanated primarily from attempts to use the asset pricing model to derive portfolio performance evaluation models. Treynor, Sharpe, and Jensen all derived such portfolio evaluation models and applied them to the historical evidence on mutual funds. The evidence presented by Sharpe and Jensen indicated that the returns on open-end mutual funds were positively related to the covariance between the fund returns and the returns on a market index used as a proxy for the market portfolio. As such, they provided some indications that the model... showed potential promise as a description of the process

> generating the returns on assets (if one was willing to accept the hypothesis that mutual fund managers were unable to select undervalued securities and did not generate excessively large expenses). However, as we shall see, the direct tests of the model imply that this interpretation of these results may be incorrect.[1]

Black, Jensen, and Scholes pointed out the empirical inconsistencies they discovered regarding the Sharpe-Lintner model.

> If empirically true, the relation given (by the Sharpe-Lintner model) has wide-ranging implications for problems in capital budgeting, cost benefit analysis, portfolio selection, and for other economic problems requiring knowledge of the relation between risk and return. Evidence presented by Jensen on the relationship between the expected return and systematic risk of a large sample of mutual funds suggests that (the Sharpe-Lintner model) might provide an adequate description of the relation between risk and return for securities. On the other hand, evidence presented by Douglas, Lintner, and most recently, Miller and Scholes seems to indicate the model does not provide a complete description of the structure of security returns. In particular, the work done by Miller and Scholes suggest that the α's on individual assets depend in a systematic way on the β's: that high-beta assets tend to have negative α's, and that low-beta stocks tend to have positive α's.[2]

BJS went on to test an expanded two-factor model which would hold under conditions when riskless borrowing was not available. The present study did not concern itself with the augmented model, but as previously stated, tested the Sharpe-Lintner model on a specific sample of common stocks have poor past performance.

A study by Sharpe and Cooper (utilizing the CAPM) of annual returns over the period 1931 through 1967 found that when the entire period was

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[1]Jensen, Michael C., "The Foundation and Current State of Capital Market Theory," in Studies in the Theory of Capital Markets, M. C. Jensen, ed. (New York: Praeger Publishers Inc., 1972), p. 7.

[2]Black, Fischer, Michael C. Jensen, and Myron Scholes, "The Capital Asset Pricing Model; Some Empirical Tests," in Jensen, Studies in The Theory of Capital Markets, p. 80.

considered, higher risk portfolios had higher returns on average than those of lower risk. Market sensitivity which included price changes but excluded cash dividends, calculated over a previous five-year period was the risk measure for the study. They found that over shorter time periods, risk-return expectations were less likely to be realized than over longer periods.

Discriminant Analysis

A 1968 study by Edward Altman was of particular interest to this research since he successfully used financial ratios in conjunction with discriminant analysis to predict corporate bankruptcy.[3] Sets of bankrupt firms and the set of securities with poor price performance comprising the present study were expected to have been closely related groups. More specifically, all bankrupt firms were expected to have had poor price performance, although, not all firms displaying large losses in market price would necessarily have been bankrupt. In addition, Altman's model used financial ratios in combination rather than separately as most previous applications of ratio analysis had done.

Altman demonstrated that his bankruptcy prediction model was an accurate forecaster of failure up to two years prior to bankruptcy. In a rigorous test of the model, he found that even among a sample of sixty-six industrial firms showing deficits in the years 1958 and 1961 (sixty-five per cent of them having shown earnings losses two or three of the previous three years reporting), only fifteen of the firms were

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[3]Altman, Edward I., "Financial Ratios, Discriminant Analysis and the Prediction of Corporate Bankruptcy," Journal of Finance (September 1968), pp. 589-609.

incorrectly classified. Thus, even in a universe of firms demonstrating below average performance, the model correctly classified seventy-nine per cent of the sample firms.

Keith Smith utilized multiple discriminant analysis to classify common stocks into distinct security groups.[4] A discriminant function, using seven financial variables, was constructed for selecting among stocks which fell into the three investment categories of investment type, trading type, and speculative type as defined a priori by the brokerage house Merrill Lynch, Pierce, Fenner and Smith. This discriminant function was then tested on a random sample of stocks. The stocks in this second sample were correctly reclassified into the proper groups in eighty-eight per cent of the cases. These results suggested that the MDA technique may be of potential value in classifying common stocks for various investment objectives. Smith went on to say that.... "it should be possible to extent the analysis to other types of investments, i.e., to search for variable profiles which characterize distinct investment opportunities and thereby enhance the portfolio selection process."[5]

Williams and Findlay had this to say about discriminant analysis:

> ...There are other techniques that are gradually coming into use by the financial community (although they have been employed by statisticians elsewhere for some time) to measure prospective asset performance. One of the more interesting of these techniques is <u>discriminant analysis</u>. This approach may be used to find those financial characteristics that best discriminate profitable investments from unprofitable

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[4]Keith V. Smith, "Classification of Investment Securities Using Multiple Discriminant Analysis," Institute Paper #101 (Purdue University: Institute for Research in the Behavioral, Economic, and Management Sciences, 1965).

[5]Ibid., pp. 33-34.

> ones. The method assumes that observations come from two distinct universes, the profitable and the unprofitable....[6]

They later sounded a note of caution, however, with the following statement:

> Although discriminant analysis has proved to be very helpful as a tool for exploratory research, some authorities feel that it is more appropriately applied to explain past relationships rather than to predict future ones. The statistical foundation for the procedure is not terribly strong, and it should be employed only by those who understand the method very well. Nevertheless, in capable hands the technique can provide added insight into the problem of classification.[7]

Both of the above statements, however, were assertions on their part with no additional explanation or empirical verification cited.

Financial Ratios

Fundamental investment analysis requires the analyst to estimate future earnings and/or dividend streams in order to arrive at an "intrinsic value" for the security. The analysis of past and present financial information has often been employed by financial analysts to aid in the prediction of future earnings or dividend streams. Financial ratios based upon publicly available information form an integral part of much financial analysis. Graham, Dodd, and Cottle stated the need for studying financial information:

> In the selection of common stocks much more emphasis is placed upon future expectations as the primary basis of attractiveness and value. In theory these expectations may be so different from past performance that the latter could be virtually irrelevant to the analysis. But this separation of the future from the past rarely occurs in

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[6] Williams, Edward E., and M. Chapman Findlay III, Investment Analysis (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1974), p. 121.

[7] Ibid., p. 125.

> practice. A tendency toward an underlying continuity in business affairs makes the financial record the logical point of departure for any future projection. Thus, it is only the trader on market movements or the heedless speculator following tips or hunches who will ignore the statistical showing of a common stock. The investment approach to every kind of security, which is the analytical approach--requires the proper application of income-account and balance sheet analysis.[8]

In a 1951 study, Latane compared price, earnings, and dividend history of the twenty-five securities exhibiting the greatest gains and losses during the four investment periods coinciding with the calendar years 1948, 1949, 1950, and 1951.[9] He found a weak tendency for those securities which had shown large percentage gains in one year to exhibit a smaller gain in the following year than that realized by securities which had shown large losses the first year. Latane also found a slight tendency for stocks to reverse their direction of price movement over the years, with stocks selling at a discount from earlier prices having a slight greater chance for price appreciation. Past price performance alone, however, was felt to be a poor guide for selecting securities. Latane found historic dividend yield to be a poor indicator of future market performance. Specifically, the dividend yield on the basis of the previous year's dividend had little or no forecasting value for future market changes. It was found also that past earnings compared with current price may have some forecasting value. In particular, stocks which had large current earnings relative to price were more

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[8]Graham, Benjamin, David L. Dodd, and Signey Cottle, Security Analysis: Principles and Techniques (New York: McGraw-Hill Book Co., 1962), Fourth Edition, pp. 105-106.

[9]H. A. Latane, "Price Changes in Equity Securities," Journal of Finance (September 1951), pp. 252-264.

likely to have been in the group having large gains than the group having large losses.

Murphy, in a 1966 study, found that companies posting relatively high rates of growth in earnings per share during one time period had no better than an even chance of recording relatively high earnings growth in the succeeding period.[10] This finding came from conducting 492 tests (covering 12 industries for 36 test periods) which compared the rate of earnings growth with the rate of price change during the same time period.[11] As might be expected, earnings were shown to have been of the utmost importance to investors. These findings could explain the lack of positive correlation of individual share price movements over time found by Latane. The finding of Latane that stocks which had large current earnings relative to current price were more likely to have fallen in the group of firms exhibiting the largest gains was further supported by a study performed by Nicholson. Nicholson compared the relative investment performance, in eleven holding periods from 1939 to 1959, of stocks on the basis of their price-earnings ratio at the time of investment.[12] Investment performance in nearly all cases was inversely related to the size of the price-earnings ratio. In addition, those stocks with large depreciation

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[10] J. E. Murphy, Jr., "Relative Growth of Earnings Per Share—Past and Future," Financial Analysts Journal (November-December 1966), pp. 73-76.

[11] J. E. Murphy, Jr., "Earnings Growth and Price Change in the Same Time Period," Financial Analysts Journal (January-February 1968), pp. 97-99.

[12] S. F. Nicholson, "Price Ratios in Relation to Investment Results," Financial Analysts Journal (January-February 1968), pp. 105-109.

charges, sales and book value relative to price at the time of investment nearly always offered superior performance in future holding periods compared with securities possessing lower values of these variables relative to price.

Molodovsky generally tended to downgrade the significance of the Nicholson results pointing out that since changes in price-earnings ratios were the result of thirteen possible combinations of changes in price and earnings, they had no real existence of their own.[13] He also criticized the study because he felt that cumulative reinvestment into the low P/E group would "strengthen" that group while the high P/E group would be steadily "weakened" through this process. Supporters of Nicholson's study contended that P/E ratios were not meant to be the sole method of stock selection but were merely a screening device which possessed considerable merit.[14] They further stated that cumulative reinvestment would not have biased the results but would only have provided an explanation for why the method apparently worked so well.

A study by Levy and Kripotos found[15] that earnings growth (as measured by the percentage change in latest available twelve-month

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[13] Molodovsky, Nicholas, "Recent Studies of P/E Ratios," Financial Analysts Journal (May-June 1967). This article was reprinted in C.F.A. Readings in Financial Analysis (Homewood, Illinois: Richard D. Irwin, Inc., 1970). Second Edition, pp. 400-413.

[14] Miller, Paul F., and Thomas E. Beach, "Recent Studies of P/E Ratios—A Reply," Financial Analysts Journal (May-June 1967). This article was reprinted in C.F.A. Readings in Financial Analysis (Homewood, Illinois, Richard D. Irwin, Inc., 1970). Second Edition, pp. 414-417.

[15] Levy, Robert A., and Spero L. Kripotos, "Earnings Growth, P/E's and Relative Price Strength," Financial Analysts Journal (November-December 1969), pp. 60-67.

earnings per share over the twelve-month earnings per share for the year ended with the prior quarter) and relative price strength (as measured by comparing the current month-end price with the average of the monthly prices for the preceding six months, inclusive through the current month) were valuable as criteria for selecting stocks which would have offered superior performance over a six-month holding period. The combination of these two factors was found to be superior to either used individually. Levy and Kripotos also concluded that P/E ratios were of comparatively little use either when used individually or in combination with the two other measures.

Joy and Jones in a follow-up study took issue with the way in which Levy and Kripotos had calculated the P/E ratio.[16] Using data which closely approximated that used by Levy and Kripotos, Joy and Jones replicated the former study using a definition of P/E which took greater account of more recent information. Nearly identical results were found except in the case where P/E ratios were concerned. They found low P/E ratios to be a very useful method of primary selection for stocks that would offer subsequent superior performance.

From the studies cited above, it can be seen that many authors believed that fundamental financial data was useful for objectively selecting stocks which would subsequently outperform the market. Most authors did not recommend that the factors examined in the studies should be the only ones considered for making investment decisions. They generally recommended that they should be used only as screening devices

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[16] Joy, O. Maurice, and Charles P. Jones, "Another Look at the Value of P/E Ratios," Financial Analysts Journal (September-October, 1970), pp. 61-64.

for narrowing down the universe of possible investments to a size more capable of comprehensive study. Possessing useful screening criteria, the argument went, the analyst could then best utilize his time studying and comparing stocks drawn from a set of securities which hoped to offer price appreciation potential superior to that of the market in general.

The authors of many of the previously cited studies assumed that objective measures or ratios could be found and applied which would aid the investment selection process. Those subscribing to this viewpoint assumed that with the aid of the proper techniques, the investor could outperform the market even after the appropriate adjustment for risk. Holding the opposite viewpoint would be those who believe the semi-strong version of the efficient market hypothesis. This theory states that the market on average correctly and instantaneously adjusts the price of any security for all publicly available information.[17] The semi-strong version of the efficient market hypothesis, if true, would imply that no objective measures, financial ratios, or special quantitative techniques could be used to select securities which would outperform the market after adjustment for risk.

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[17]For example this viewpoint is well expressed in Eugene F. Fama, "Efficient Capital Markets: A Review of Theory and Empirical Work," Journal of Finance, vol. 25, no. 2 (May 1970), pp. 383-417.

CHAPTER III

METHODOLOGY

Test of the Capital Asset Pricing Model

The initial sample used for testing consisted of the twenty common stocks listed on the New York Stock Exchange which experienced the greatest percentage declines in price during the calendar years 1956 through 1971. Various subperiods from these years were selected for additional tests which were conducted. The firms used were industrial companies (transportation, banking, finance, and utility stocks were excluded) which had calendar year accounting periods. The sample of firms is listed in the appendix.

The validity of the Sharpe-Lintner capital asset pricing model (CAPM) was tested as a guide for small portfolio investment over short holding periods in common stocks with poor past performance. The research determined whether securities from the revised sample had realized returns over the holding periods consistent with returns conditionally expected by the CAPM, given the holding period return of the market. Twelve portfolios were tested over the same number of one-year holding periods. Ten three-year holding period returns were also tested over the same period of time from 1957 to 1969.

According to the Sharpe-Lintner CAPM each portfolio and holding period would have an expected return $E(R_{pt})$, given the historical average portfolio beta, b_p, and the market return over the same period,

R_{Mt}. This conditional expected return is given as:

$$(E\ (R_{pt})\ /\ b_p,\ R_{Mt}) \tag{1}$$

The expected return on a portfolio, $E(R_p)$, is equal to the degree of nondiversifiable risk, β_p, times the expected return of the market, $E(R_M)$.

$$E(R_p) = \beta_p E(R_M) \tag{2}$$

The CAPM asserts that return should be positively related to β_p, the measure of risk. The model was tested using the relationship

$$E(R_{pt}) = b_p R_{Mt} \tag{2.1}$$

where $E(R_{pt})$ is the conditional expected return of the portfolio over time t, given R_{Mt}, the realized return of the market over the same time period and b_p, the historical portfolio beta. To use the CAPM as the basis of an investment strategy it was necessary to have an ex ante risk level measure, b_p, which estimated β_p, the true risk level. The beta coefficients of individual securities, b_i, are calculated by regressing historical security returns on historical market returns. The b_p is the weighted average of these individual b_i values. Studies by Levy[1] and Blume[2] have demonstrated these beta estimates to be quite stable over time at the portfolio level. While some individual securities exhibited increasing betas, others showed declining betas, and the

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[1]Robert A. Levy, "On the Short-Term Stationarity of Beta Coefficients," Financial Analysts Journal (November 1971).

[2]Marshall E. Blume, "On the Assessment of Risk," Journal of Finance (March 1971).

portfolio beta, an average, remained quite stable.

Because of time and resource limitations, beta coefficients for the firms comprising the study were not calculated. Instead, "market sensitivity" coefficients supplied by Sharpe and Cooper[3] were used. These coefficients were calculated using the monthly price changes for the most recent 5 year past.

Market sensitivity coefficients were calculated the same way as the beta coefficient except that the dividend yield was not a part of the holding period return. The two measures differ very little, however, since dividend yields were shown by Sharpe and Cooper to have been very stable over time, when compared to price changes. Ten risk return deciles were provided, along with the historical betas which corresponded to each decile. Thus, given the decile risk class a firm belonged to, the beta corresponding to that risk class was assigned to the firm. This beta assignment process was only approximately correct, however, since the betas for each decile represented the average beta for that decile over the entire 1931-1967 period. During individual years the beta for each decile may have varied slightly from its 1931-1967 average. The degree to which the beta may have varied, however, was not specified. In light of the previously mentioned Blume and Levy studies which had demonstrated the stability of portfolio beta coefficients over time, the long-term average beta for each decile was felt to constitute a very close approximation to the true yearly decile beta. Accordingly, the betas in each portfolio of this study were the

[3]William F. Sharpe and Guy M. Cooper, "Risk-Return Classes of New York Stock Exchange Common Stocks, 1931-1967," Financial Analysts Journal (March 1972).

average of the betas of the risk classes to which each stock of the portfolio belonged.

The traditional definition of holding period return includes both price appreciation and cash dividends. Since cash dividends are difficult to obtain and verify, they were not included in the returns of the present study. For the purpose of this study the price appreciation figures during the 22 time periods were defined as holding period returns, realizing that this did constitute a departure from traditional practice.

Market sensitivity (MS), taking the Sharpe and Cooper definition, was defined as "the slope of a regression line relating the appreciation on a portfolio or security to that of the market."[4] They found a very close relationship between MS and beta[5]

$$\begin{aligned} \text{Beta} &= .004 + .997\ (\text{MS}) \\ R^2 &= .996 \end{aligned} \tag{3}$$

The test procedure of the present study involved comparing the actual holding period return with the conditional expected holding period return given the return of the market and the measure of systematic risk. The actual portfolio holding period return (R_{pt}^A) was the percentage change in price for the portfolio over each holding period, adjusted for stock splits and stock dividends. As noted previously, cash dividends were not included. The conditional expected portfolio holding period return over time t was

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[4]Ibid.

[5]Ibid.

$$E(R_{Pt}) = MS_P R_{MT} \tag{2.2}$$

where MS_P was the measure of systematic risk and was taken from (3) by solving for market sensitivity

$$MS_P = (b_P - .004) / .997$$

The null hypothesis was that the average difference $\overline{D}$, between expected portfolio return, $E(R_{Pt})$, and actual return, R_{Pt}^A,

$$D_t = R_{Pt}^A - E(R_{Pt})$$

$$\text{where } \overline{D} = \frac{1}{n} \sum_{t=1}^{n} D_t$$

was equal to zero while the alternative hypothesis was that they were not, where

$$H_0 : \overline{D} = 0$$

$$H_1 : \overline{D} \neq 0$$

One paired difference t-test was made at the .05 level of significance for the 12 one-year holding period return differences, and another for the 10 three-year holding periods return differences. The t-test was based upon the three following assumptions.

1. The underlying populations from which the samples were drawn were normally distributed.
2. The variances of these distributions were the same (homogeneous).
3. The samples were independently drawn and therefore had independent errors.

The last assumption was easily satisfied since the samples drawn in consecutive holding periods were certainly not dependent. This is supported by abundant evidence available in connection with numerous tests of the random walk hypothesis which have suggested the lack of any significant dependence in stock prices over time.[6]

In regard to the first two assumptions, Fama has suggested that a stable Paretian distribution (symmetrically shaped like the normal distribution except for greater thickness in the tails) might more appropriately describe the distribution of security returns than the normal distribution.[7] There was no a priori reason for believing the distributions of actual and conditionally expected holding period returns to be fundamentally different in shape, though the possibility of unequal variances could not be excluded. In exhaustive empirical tests assessing violations of assumptions underlying the t-test, Boneau found that the t-test was remarkably robust under a wide variety of assumption violations. Quoting in part from the aforementioned study

> We may conclude that for a large number of different situations confronting the researcher, the use of the ordinary t test and its associated table will result in probability statements which are accurate to a high degree even though the assumptions of homogeneity of variance and normality of the underlying distributions are untenable. This large number of situations has the following general characteristics: (a) the two sample sizes are equal or nearly so, (b) the assumed underlying population distributions are of the same shape or nearly so. (If the distributions are skewed they should have nearly the same variance.) If these conditions are met, then no matter what the variance differences

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[6]Eugene F. Fama, "Efficient Capital Markets: A Review of Theory and Empirical Work," Journal of Finance 25 (May 1970), pp. 383-417.

[7]Eugene A. Fama, "Portfolio Analysis in a Stable Paretian Market," Management Science, 11: 404-419 (January 1965).

> may be, samples of as small as five will produce results for which the true probability of rejecting the null hypothesis at the .05 level will more than likely be within .03 of that level. If the sample size is as large as 15, the true probabilities are quite likely within .01 of the nominal value. That is to say, the percentage of times the null hypothesis will be rejected when it is actually true will tend to be between 4% and 6% when the nominal value is 5%.[8]

The above quotation demonstrated the robustness of the t-test under conditions almost identical to those of the present study, therefore, the t-test was deemed appropriate. The test statistic was

$$t = \frac{\bar{D} - 0}{S_{\bar{D}}}$$

with n-1 degrees of freedom and where $S_{\bar{D}} = S_D/\sqrt{n}$ for a sample of size n. The same distribution was assumed to apply to each of the individual pair differences; the sample standard deviation, S_D was calculated as follows:

$$S_D = \sqrt{\frac{\sum(D_t - \bar{D})^2}{n-1}}$$

The 1-year tests involved 12 holding periods and therefore 11 degrees of freedom, while the 3-year tests encompassed 10 holding periods for 9 degrees of freedom. The .05 critical values of t were for the one and three year tests respectively, ±2.201 and ±2.262. If the sample test statistic had possessed an absolute value less than or equal to the critical value the null hypothesis was not rejected; if it were greater, the null hypothesis would have been rejected.

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[8]C. A. Boneau, "The Effects of Violations of Assumptions Underlying the t-Test," Psychological Bulletin, Vol. 57, p. 62.

Discriminant Analysis Tests

A general problem to which multiple discriminant analysis (MDA) has been frequently directed is one requiring the ex ante prediction of which of two or more distinct groups various elements in a population belong.[9] The prediction of group membership is based upon a linear combination of measured characteristics (predictor variables) for each element. This linear combination, termed the discriminant function, predicts group membership based upon the numerical value achieved by each element of a subsequent sample from the same hypothesized population. The measured characteristics are multiplied by the constant coefficients of the discriminant function and assigned to one of the groups based upon the score achieved. For the two group case, those with high scores would be assigned to one group while those with low scores would be assigned to the other.

In general, discriminant analysis would require the following assumptions when tests of significance are to be made on the functions:[10]

1. the investigated groups are identifiable and discrete.
2. measured characteristics can describe each element in each group.
3. each measured characteristic is assumed to have a multivariate normal distribution in each group and an equal

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[9]The mathematical development of discriminant analysis is well treated elsewhere. For example see C. R. Rao, Advanced Statistical Methods in Biometric Research (New York: Wiley, 1952), and J. G. Bryan, "The Generalized Discriminant Function, Mathematical Foundation and Computational Routine," Harvard Educational Review, vol. XXI, No. 2 (Spring 1951), pp. 90-95.

[10]Robert A. Eisenbeis, Discriminant Analysis and Classification Procedures (Lexington, Mass.: D.C. Heath and Co., 1972), pp. 1-2.

common variance.

The first assumption would appear to have been satisfied in the case of this study since there were two distinct mutually exclusive and collectively exhaustive groups to which a stock could have been classified into--those who subsequent to the year of large price loss outperformed the Standard and Poor's 425 Industrial Index, and those which underperformed the same index during the ensuing holding period. The financial ratios were measurable for each stock in the study, thus having satisfied the second condition. It was less clear, however, whether each measured characteristic was normally distributed in both groups with a common variance. The small sample sizes of the study made verification of the third assumption impractical since the central portion of the sample distribution of measured characteristic values might appear rather normal while the tails, where there are by definition few observations, could actually be nonnormal.[11]

When the third assumption is violated, the F-test for significance (the statistic which is used to test the significance of the MDA function) has been shown to become very nonrobust.[12] However, these

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[11]For a much fuller discussion of the problem of assumptions about the underlying population distribution see James V. Bradley, Distribution--Free Statistical Tests (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1968), pp. 6-8.

[12]While the t-test is reasonably robust against nonnormality, even infinite sample sizes will not produce perfect robustness against nonnormality for the F-test, nor can perfect robustness be attained for heterogeneity of variance in the general case. When both assumptions are jointly violated the true significance of the F-test is nearly impossible to determine. A partial list of the other factors which bear on robustness includes: location of rejection region, size of significance level, minimum sample size, absolute sizes of the other samples, relative sample sizes, total number of samples upon which the test is based, number of samples of each absolute

assumptions may be relaxed when instead of testing for the significance of the discriminant function, MDA is used strictly as a classification technique for predicting group membership.

The evaluation of the usefulness of MDA was based upon how well it actually succeeded in ex ante classifying securities for investment purposes.[13] Specifically, the actual performance ranks were compared to the performance ranks predicted by the discriminant function scores. In all tests the sole criterion for evaluating MDA was its ability to correctly classify, according to performance ranks, securities which were not part of the sample from which the discriminant functions were calculated.

The tests for determining the ability of discriminant analysis to select common stocks with superior investment potential, given objective financial information, were made in two parts. The first part concerned the ability of the discriminant functions to correctly classify, during the same time period, securities not included in the group from which the discriminant functions were constructed. The second test determined whether securities from later time periods could be correctly classified by the discriminant functions. After discussing the sample of companies and the data items from each which were collected, these two tests are specified in detail.

(and relative) size, etc. These points are discussed in more detail in Bradley, Distribution--Free Statistical Tests, pp. 26-27, and Bradley, "Studies in Research Methodology VL. The Central Limit Effect for a Variety of Populations and the Robustness of Z, t, and F," AMRL Technical Report 64-123, Aerospace Medical Research Laboratories, Wright-Patterson Air Force Base, Ohio, December, 1964.

[13]The significance of the discriminant functions was not calculated due to the nonrobustness of the F-test, which would make the true significance level of the functions nearly impossible to determine.

Sample and Data Items

The twenty common stocks listed on the New York Stock Exchange with the greatest percentage price declines during the calendar years 1962 through 1971 comprised the original sample of companies for the MDA study. As in the previous test of the CAPM, those firms which did not have calendar year accounting periods and which were not industrials (thus excluding transportation companies, utilities, and financial institutions) were discarded from the sample.

1. Net Operating Margin--defined as net operating income dividend by sales. This ratio indicated how much of every sales dollar remained in net operating income.
2. Operating Asset Turnover--defined as sales divided by net operating assets, where net operating assets were total assets less intangible items such as patents, copyrights, or goodwill. This ratio measured the efficiency with which the firm utilized its operating assets, for the smaller the asset investment necessary to generate a given level of sales the better off the firm would be, other things equal.
3. Net Working Capital/Total Assets--defined as current assets less current liabilities divided by the book value of total assets. This was a liquidity ratio which measured net liquid assets compared to total capitalization. A firm showing consistent operating losses would generally exhibit a declining liquidity position. Altman found this ratio to be more useful than either the current ratio or the quick ratio in his

bankruptcy prediction model.

4. Net Working Capital/Market Value of Common Equity--where market value of common equity was defined simply as the number of common shares outstanding times the market price of common stock. Firms having had a high degree of liquidity relative to market value per share would likely be stronger financially and more resistant to insolvency than firms with less liquidity.

5. Retained Earning/Total Assets--this ratio was found by Altman to be a useful ratio for predicting bankruptcy because it measured cumulative profitability over time. Firms which have large cumulative profits have exhibited a measure of survivability through the crucial early years of their existence. To the extent that this ratio can indicate future resistance to bankruptcy, it would provide a necessary (but not sufficient) precondition for future earnings and price apprecaition.

6. Times Interest Charges Earned--defined as net operating income dividend by fixed interest charges. This ratio was an indicator of the safety level of long term debt issues. In general, the more times the interest has been earned, the safer the company. One minus the reciprocal of this measure indicates the percentage that operating income could drop before the most junior debt issue would be jeopardized.

7. Earnings Change Per Dollar of Price--defined as the most recent yearly earnings per share less those of a year

previous, divided by the price of the present year. A similar ratio was utilized by Niederhoffer and Regan to take account of earnings changes, particularly for firms showing deficits.[14] By normalizing with price, the large percentage earnings changes which would occur when earnings change within a very close range of zero are placed in a format for which interfirm comparisons could be more easily made.

8. Percentage Change in Sales--firms with growing sales would be expected to be in a relatiavely stronger position, other things equal, than those with level or declining sales.

9. Percentage Change in Working Capital--increasing working capital generally indicated a stronger liquidity position and more resistance to insolvency, other things equal.

10. Percentage Change in Net Operating Income--growing net operating income usually would indicate greater company strength arising from the chief lines of business.

11. Current Ratio--defined as current assets divided by current liabilities. This is perhaps the most common liquidity measure in use.

12. Current Ratio as a Percentage of the Industry Average--defined as the current ratio of the firm compared to that of the four digit industry to which the firm belongs.

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[14] Victor Niederhoffer and Patrick J. Regan, "Earnings Changes, Analysts' Forecasts and Stock Prices," Financial Analysts Journal (May 1972), pp. 67-69.

This and the following two ratios measured the relative strength of the firm compared to its industry. It would be expected that for some firms these measures might be rather high (low) relative to all firms but quite low (high) compared to other firms in the industry, thus industry effects would be adjusted for.

13. Net Operating Margin as a Percentage of the Industry Average
14. Operating Asset Turnover as a Percentage of the Industry Average

The preceding 14 financial measures were drawn largely from financial statements found in Moody's Industrial Manuals, since many of the firms were not included in the Compustat Data Tapes, mainly because of mergers, bankruptcies, and delistings since the years of large losses. The industry averages for the last three ratios, however, were drawn from the Compustat Tapes. All data items were drawn either during or before the year of the large price loss with no items taken after the year of the loss.

Test Procedures

The returns of all companies in the sample were calculated for holding periods beginning on the first trading day of the April following the year of the large price loss and extending until periods one and three years after the year of extreme decline. Thus the holding periods were nine and thirty-three months in length. April was chosen as the beginning of the holding periods to ensure that, since public information for many stocks would not be generally available immediately following the year of large price loss, an investment strategy of the type tested here could actually have been employed. Cash dividends were not a part of the holding period returns calculated.

Holding periods of nine and thirty-three months in duration subsequent to the April following the end of the calendar years of poor price performance from 1962 through 1966 formed the sample period. The test period included the calendar years of poor performance from 1967 through 1971. Two dichotomizations of the samples were made. The first was simply the nine and thirty-three-month holding periods already mentioned. These holding periods were additionally segmented according to whether the year of poor performance took place during a year in which the market either rose or fell, with reference to the Standard and Poor's 425 Industrial Index. It was determined whether certain factors became more important for differentiating the future performance of stocks which had performed poorly during years when the general market rose than for those stocks which declined markedly in price during years when the general market fell.

The discriminant analysis tests were of two major categories. For the first category, the sample from the 1962-1966 period was utilized to test whether discriminant analysis could on a statistically significant basis rank stocks according to their performance during the same holding period in which the discriminant function was calculated. For the second category, it was determined whether MDA could in a statistically significant manner, rank according to performance, the later 1967-1971 test period sample. In this latter test, the discriminant functions calculated from the 1962-1966 period data were tested on the 1967-1971 data, thus evaluating the predictive ability of MDA.

Computer programs BMD07M, Stepwise Multiple Discriminant Analysis, and BMD04M, <u>Discriminant Analysis for Two Groups</u> were used on the Control Data 6500 series computer at Michigan State University. BMD07M selected the variable combination which best discriminated between those firms which increased in price relative to the market and those which decreased during the nine- and thirty-three-month holding periods relative to the market index. Program BMD04M calculated the discriminant functions after being given the optimum variable combination determined by BMD07M.

The first discriminant analysis test category determined whether MDA, used in conjunction with the financial data items, could select a linear combination of objective factors (the discriminant function) which could differentiate performance during the <u>same</u> time period as that in which the discriminant function itself was calculated. The discriminant process would be biased when the sample utilized to calculate the functions is then classified by these same functions. To overcome this bias, firms were randomly held out from the sample <u>before</u> the discriminant functions were calculated. This holdout sample was later ranked by the functions. The process in which samples were randomly withheld and then ranked following the procedure outlined above was repeated twice in order to overcome degree of freedom difficulties which would have been encountered if too many firms were withheld from each run.

To summarize the testing procedure, two holdout runs of tests were performed to ascertain the performance differentiating ability of MDA during the <u>same</u> time period as that from which the discriminant functions were calculated. One run utilizing the full sample was made from the 1962-1966 data and tested on the <u>later</u> 1967-1971 test period.

Within each data run, six discriminant functions were tested. Of these six functions, three were concerned with nine-month holding period returns, and three were for thirty-three-month returns. Of each set of three, one function was constructed from those calendar years within the period 1962-1966 during which the S&P 425 Index rose. Another function included those years in which the market index fell. Of these three functions, the third included all years from the 1962-1966 period without reference to whether the market rose or fell.

Two holdout sample runs and one full sample run were thus performed. Each run resulted in six discriminant functions. The two holdout runs were developed using 1962-1966 data and then tested using the randomly withheld firms from the 1962-1966 period, while the functions calculated from the full sample run (utilizing the entire 1962-1966 sample) were evaluated for predictive ability in the 1967-1971 test period.

The number of predictor variables utilized in each discriminant function was in the general case limited to a maximum of six. Fewer variables were permitted in those cases when the function, in which these variables were included, was used to reclassify the sample firms (whose data was used to generate the functions), and perfect reclassification occurred. More than six variables could have been used in many cases, however, the marginal improvements in reclassification ability did not appear striking enough to warrant the inclusion of more than six variables.

Firms were ranked for predicted performance in the ensuing holding period according to their discriminant scores. They were also ranked by realized return in those holding periods. The null hypothesis was that no correlation existed between the predicted and actual return ranks. The alternative hypothesis was that significant correlation did exist. Realized and predicted return ranks were correlated with the Spearman Rank Order Correlation Coefficient. The test statistic was

$$r_s = \frac{n \sum_{i=1}^{n} x_i y_i - \left(\sum_{i=1}^{n} x_i\right)\left(\sum_{i=1}^{n} y_i\right)}{\sqrt{\left[n \sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2\right]\left[n \sum_{i=1}^{n} y_i^2 - \left(\sum_{i=1}^{n} y_i\right)^2\right]}}$$

where n is the number of firms in the holdout sample, x is the actual integer performance rank in the holdout sample, while y is the integer rank predicted by the discriminant function. The null and alternative hypotheses

$H_0 : p \leq 0$

$H_1 : p > 0$

were tested at the $\alpha = .05$ level of significance.

The Spearman rank correlation coefficient was selected as the test statistic since performance ranking abaility was felt to be the most meaningful criterion of usefulness for investment purposes. The chief reason for having chosen the nonparametric Spearman rather than the parametric Pearson correlation coefficient was that the former test does not depend upon assumptions about the underlying distribution of the actual and predicted values. It only requires the assumption that they be continuous, and under the null hypothesis, independent. Both assumptions were easily satisfied. This test, when compared to the

Pearsonian r under conditions where all conditions of the latter test hold has an asymptotic relative efficiency of .912.[15]

[15] A. Stuart, "Asymptotic Relative Efficiency of Tests and the Derivatives of their Power Function," Skandinavisk Aktaurietidskrift, parts 3-4, pp. 163-169.

CHAPTER IV

RESULTS

Capital Asset Pricing Model Test Results

Table 4.1 below shows the results of the CAPM test for the portfolios held for one-year periods. Table 4.2 shows the results for the three-year holding periods. Column (1) of each table lists the individual periods. These periods ran from January 1 to January 1 of the years given. Column (2) lists the number of securities which comprised each individual portfolio. This number differs from the preliminary sample of twenty due to the exclusion of firms with noncalendar year accounting periods and those which were not industrials. Column (3) lists the observed market returns (represented by the S&P 500 Composite Index), R_{Mt}, for each time period t.

Column (4) lists the historical average beta, b_p, for each portfolio. The portfolio beta is modified by the adjustment factor estimated by Sharpe and Cooper[1] and given by equation (3) of the previous chapter. At two significant digits the beta and market sensitivity measures for each portfolio were identical in all but one case. Column (6) lists the conditional expected portfolio return, given the historical beta and the market return over the same holding period.

[1]William F. Sharpe and Guy M. Cooper, "Risk-Return Classes of New York Stock Exchange Common Stocks, 1931-1967," Financial Analysts Journal (March 1972).

This value was calculated by formula (2.2) of the previous chapter. Column (7) shows the observed portfolio returns over the holding periods, while column (8) shows the differences between actual and expected portfolio returns. As discussed in the previous chapter, returns were defined for this study so as to exclude cash dividends; both actual and expected returns were adjusted for this exclusion. Column 8 of Tables 4.1 and 4.2 show in particular how large the differences between actual and expected returns frequently were.

The paired difference test of the CAPM involved calculating the t statistic for the differences between actual and conditional expected returns:

$$t = \frac{\overline{D} - 0}{S_d \;/\; \sqrt{n}}$$

Where the D values were as given in column (8) of Tables 4.1 and 4.2, and $\overline{D} = \frac{1}{n} \sum_{t=1}^{n} D_t$. S_d was the sample standard deviation of return differences, while n was the sample size. The hypotheses were

$$H_0 : \overline{D} = 0$$

$$H_1 : \overline{D} \neq 0$$

tested at the α level of .05.

For the 1-year holding period returns the test statistic was

$$t = \frac{.0415 - 0}{.2702 \;/\; \sqrt{12}} = .53225$$

with a critical value of ±2.201 and 11 degrees of freedom. For the 3-year holding period returns

TABLE 4.1

ONE YEAR HOLDING PERIOD RETURN DATA

(1) Time Period Beginning of Years	(2) Number of Secu-rities	(3) Market Return R_{Mt}	(4) Port-folio Beta b_p	(5) Market Sensi-tivity MS_p	(6) Conditional Expected Return $E(R_{Pt}/b_p,R_{Mt})$	(7) Actual Observed Portfolio Return R^A_{Pt}	(8) Difference Between Actual and Expected Portfolio Return $D_t=R^A_{Pt}-E(R_{Pt}/b_p,R_{Mt})$
1957-1958	11	-.127	1.18	1.18	-.150	-.397	-.247
1958-1959	16	.375	1.25	1.25	.469	.968	.499
1959-1960	9	.081	.93	.93	.075	.072	-.003
1960-1961	8	-.039	1.04	1.03	-.040	-.108	-.068
1961-1962	11	.233	1.35	1.35	.314	.132	-.182
1962-1963	11	-.117	1.08	1.08	-.126	-.230	-.104
1963-1964	8	.203	1.12	1.12	.227	-.021	-.248
1964-1965	12	.117	1.16	1.16	.136	.202	.066
1965-1966	10	.094	1.17	1.17	.110	.366	.256
1966-1967	7	-.128	.85	.85	-.109	-.150	-.041
1967-1968	9	.196	1.00	1.00	.196	.773	.577
1968-1969	5	.081	1.18	1.18	.096	.090	-.006

TABLE 4.2

THREE YEAR HOLDING PERIOD RETURN DATA

(1) Time Period Beginning of Years	(2) Number of Securities	(3) Market Return R_{Mt}	(4) Portfolio Beta b_p	(5) Market Sensitivity MS_p	(6) Conditional Expected Return $E(R_{Pt}/b_p,R_{Mt})$	(7) Actual Observed Portfolio Return R^A_{Pt}	(8) Difference Between Actual and Expected Portfolio Return $D_t=R^A_{Pt}-E(R_{Pt}/b_p,R_{Mt})$
1957-1960	11	.297	1.18	1.18	.351	.420	.069
1958-1961	16	.427	1.25	1.25	.534	.972	.438
1959-1962	9	.280	.93	.93	.260	-.010	-.270
1960-1963	8	.046	1.04	1.03	.048	.029	-.019
1961-1964	11	.310	1.35	1.35	.417	.100	-.317
1962-1965	11	.187	1.08	1.08	.202	-.008	-.210
1963-1966	8	.470	1.12	1.12	.526	.437	-.089
1964-1967	12	.066	1.16	1.16	.076	.439	.363
1965-1968	10	.141	1.17	1.17	.165	.552	.387
1966-1969	7	.127	.85	.85	.108	2.390	2.282

$$t = \frac{.2634 - 0}{.76141 / \sqrt{10}} = 1.0939$$

with a critical value of ±2.262 and 9 degrees of freedom. Both tests were clearly not able to reject the null hypothesis of no significant difference between actual and predicted portfolio holding period returns.

The above t-tests showed that on average the CAPM predictions were unbiased when the entire test period was taken as a whole, while for the individual portfolios and holding periods tested, the actual returns in many cases differed markedly from those predicted by the CAPM.

Discriminant Analysis Tests Results

The variables considered by the stepwise multiple discriminant analysis routine are listed as follows:

1. Net Operating Margin
2. Operating Asset Turnover
3. Net Working Capital/Total Assets
4. Net Working Capital/Market Value of Common Equity
5. Retained Earnings/Total Assets
6. Times Interest Charges Earned
7. Earnings Change Per Dollar of Price
8. Percentage Change in Sales
9. Percentage Change in Working Capital
10. Percentage Change in Net Operating Income
11. Current Ratio
12. Current Ratio as a Percentage of the Industry Average
13. Net Operating Margin as a Percentage of the Industry Average

14. Operating Asset Turnover as a Percentage of the Industry Average

Table 4.3 lists the variables selected by the stepwise discriminant routine for each of the eighteen discriminant functions. The numbers correspond to the variable listing shown above. The variables selected are listed in declining order of importance to their respective discriminant functions. Table 4.4 lists the variables which are common to all three data runs for each holding period. This gives a rough indication of the stability of the relationships. That is, the lower degree of commonality, the greater the likelihood that any relationship underlying the profile of variables found by the stepwise routine was spurious rather than real. Table 4.4 indicates that more variables were common for the calendar years when the market increased than for those years when the market declined, and that the highest degree of commonality occurred when all years were combined. More commonality would be expected to occur if the relationships were stable during the sample period and to become more pronounced as sample size were increased.

Tests of the classification ability of discriminant analysis were made utilizing the Spearman Rank Correlation Coefficient as the test statistic. For each of the eighteen discriminant functions, the predicted rank order based upon the discriminant score was correlated with the actual rank order score. For the first twelve discriminant functions, the discriminant scores for each of the firms in the holdout sample were ordered and compared with their performance ranks based upon actual returns during the same holding period. For the predictive power test of discriminant analysis, the last six discriminant functions were applied to corresponding data for firms in the 1967-1971 period.

TABLE 4.3

VARIABLES SELECTED FOR EACH HOLDING PERIOD-DISCRIMINANT FUNCTION LISTED IN DECLINING ORDER OF IMPORTANCE

Length of and Particular Holding Period (HP) Subsequent to (calendar year of poor performance)	Data Runs: First Holdout	Data Runs: Second Holdout	Data Runs: Full Sample
9 month HP subsequent to years market declined (1962, 1966)	3,9,4,10,6	3,12,9,6	7,3,5,1,8,2
9 month HP subsequent to years market gained (1963-1965)	8,5,4,10,9,6	1,8,5,9,4,6	1,8,5,4,2,6
33 month HP subsequent to years market declined (1962, 1966)	9,8,13,4,10,2	3,9,4,13,14	1,9,8,4,2,6
33 month HP subsequent to years market gained (1963-1965)	7,5,10,8,14,11	3,14,1,12,10,9	3,14,10,4,11,9
9 month HP subsequent to all years (1962-1966)	8,10,2,14,11,4	8,2,14,4,10,6	8,3,2,14,4,10
33 month HP subsequent to all years (1962-1966)	1,8,13,2,11,6	1,13,2,8,11,6	1,13,8,2,11,6

TABLE 4.4

VARIABLES COMMON TO ALL THREE DATA RUNS FOR EACH HOLDING PERIOD

Length of and Particular Holding Period (HP) Subsequent to (calendar year of poor performance	Common Variables
9 month HP subsequent to years market declined (1962, 1966)	3
9 month HP subsequent to years market gained (1963-1965)	8,5,4,6
33 month HP subsequent to years market declined (1962, 1966)	9,4
33 month HP subsequent to years market gained (1963-1965)	10,14,11
9 month HP subsequent to all years (1962-1966)	8,10,2,14,4
33 month HP subsequent to all years (1962-1966)	1,8,13,2,11,6

That is, firms in the 1967-1971 test period which were drawn from years in which the general market declined (1969 and 1970) were used to test the nine- and thirty-three-month discriminant functions which had been constructed utilizing only those samples of firms which had been drawn from those years in the sample period in which the market had declined (1962 and 1966).

The test statistic was

$$r_s = \frac{n \sum_{i=1}^{n} x_i y_i - \left(\sum_{i=1}^{n} x_i\right)\left(\sum_{i=1}^{n} y_i\right)}{\sqrt{n \sum_{i=1}^{n} x_i^2 - \left(\sum_{i=1}^{n} x_i\right)^2 \quad n \sum_{i=1}^{n} y_i^2 - \left(\sum_{i=1}^{n} y_i\right)^2}}$$

where n is the number of firms being ranked, x_i is the actual performance rank and y_i is the rank predicted by the discriminant function--for any firm $i = 1,2, \ldots, n$. The resulting r_s correlation coefficient was compared to the .05 significance level for an upper-tail test. If the r_s value exceeded the critical value, the null hypothesis of "no association" between actual and predicted ranks would be rejected. Alternatively, if r_s did not exceed the critical value, the null hypothesis would not be rejected.

Table 4.5 shows the sample r_s values for each discriminant function. When these sample statistic values were compared with the critical values of the test statistic, none were found significant at the five percent level. That is, correlations of the magnitude found could be expected to have occurred randomly more often than 5 times out of 100 if the predicted and actual ranks were uncorrelated. It also can be seen that 11 of the 18 functions have the correct sign. If no relationship whatsoever existed, one would have expected roughly

TABLE 4.5

SPEARMAN RANK CORRELATION COEFFICIENT VALUES (R_s) FOR EACH DISCRIMINANT FUNCTION

Length of and Particular Holding Period (HP) Subsequent to (calendar year of poor performance)	First Holdout	Second Holdout	1967-1971 Test Period
9 month HP subsequent to years market declined (1962, 1966)	.60	.70	-.20
9 month HP subsequent to years market gained (1963-1965)	-.10	-.60	-.44
33 month HP subsequent to years market declined (1963, 1966)	.10	-.30	.07
33 month HP subsequent to years market gained (1963-1965)	.30	.70	-.01
9 month HP subsequent to all years (1962-1966)	.24	.44	-.03
33 month HP subsequent to all years (1962-1966)	.05	.42	.18

as many positive as negative correlations; the 11 positive correlations found here were only slightly more than the 9 which would be expected to occur on average due to random causes.

CHAPTER V

CONCLUSIONS

The results of this study have indicated that the Sharpe-Lintner capital asset pricing model (CAPM) was not inappropriate when used as the basis for an investment strategy involving portfolios of securities with poor past performance. For small portfolios and relatively short holding periods of one and three year duration, the tests conducted were not able to reject the null hypothesis of no significant difference on average between observed portfolio returns and expected returns conditional upon knowledge of the market return over the holding period and the historically calculated portfolio beta coefficient.

While the differences between observed and conditional expected returns were <u>on average</u> not significantly different from zero over the 12 one-year periods and 10 three-year periods, they were often quite large in the individual periods when considered separately. This phenomenon could be important for the individual small investor since in the absence of holding shares in a mutual fund or other diversified portfolio, he may be limited to a small portfolio of securities. If, as is sometimes the case, his holding period horizon is also relatively short, the conditional expected return given by the CAPM may not be of significant value to him. The observation that realized returns may depart significantly from conditional expected returns during individual holding periods was not per se inconsistent with the CAPM, however, since the model deals with expected returns which are of course observable. The model also was primarily concerned with expected returns on average over many portfolios and time periods, and much less over the behavior of individual portfolios. The small investor, nevertheless, should be made aware that his actual portfolio returns during individual holding periods may frequently be far different from expectations based upon the CAPM.

The study done by Black, Jensen, and Scholes (BJS) showed evidence that on average over the 35-year period studied, high beta portfolios consistently returned less than expected according to the Sharpe-Lintner CAPM and low beta portfolios on average returned more than expected. This tendency was particularly pronounced in the latest subperiod (April, 1957 - December, 1965) studied. Since the BJS study dealt with much larger portfolios, however, the results of the present study may not present strong evidence to either confirm or deny the BJS study results.

For all one-year holding periods taken together, the arithmetic average beta of the present study was approximately 1.1 while the average difference between actual and conditional expected returns in the paired—difference t-test was .0415. Thus, average annual observed returns were on average larger (though not to a statistically significant degree) than returns conditionally expected by the CAPM. However, while a beta of 1.1 is above the market average of 1.0, it is still definitely in the middle range of possible beta values. The results appear to have been mildly inconsistent with those of the BJS study since for their study, the decile (of the April, 1957 - December, 1965) portfolio with a beta closest to the 1.1 of the present study had a small but negative excess return (thus indicating that observed returns on average fell short of those predicted by the Sharpe-Lintner CAPM). For the three-year holding periods of the present study the average of the separate portfolio betas was again approximately 1.1, while the average difference between actual and conditional expected returns was again positive at .2634, and of the wrong sign compared with the negative excess return given by the BJS study. The results of the present study were based upon a small sample of firms and concerned average annual and 3-year returns, while the BJS study concerned average monthly returns. The above interpretation of the results of this study relative to those of the BJS study must, therefore, be regarded as tentative and primarily observational.

The results of the tests concerning multiple discriminant analysis uniformly indicated that it was of little value when used as a tool for ex ante separating winners from losers on the basis of known financial variables. It was not suggested anywhere by the tests that the discriminant functions had any significant ability to rank securities ex ante according to performance. The classifications of securities into groups which subsequently either increased or decreased relative to the market in 9- and 33-month holding periods was generally quite good when the same securities which were used for deriving the discriminant functions were reclassified by these same discriminant functions. That procedure, however, is biased and was, therefore, not part of the study.

Because of the inability of discriminant analysis to differentiate performance, it may be useful to speculate on reasons why. The first and most persistent explanation would be that the market is semi-strong efficient, thus any attempt to find superior performing securities from past publicly available information would be doomed to failure. Another explanation might be that discriminant analysis is simply not a powerful enough technique to isolate true relationships which may exist between past publicly available information and future price performance. Discriminant analysis would appear to be useful only for aiding the understanding of past relationships. The inclusion of subjective informational inputs, however, such as analysts' forecasts of such items as earning, sales growth, or market share for particular company products might be expected to aid the ex ante predictive power of discriminant analysis, although additional research would be required. As a topic for further study, discriminant analysis perhaps should be tested on a sample of firms all from the same industry. It might be that if interindustry differences in ratios are adjusted away, discriminatory power would improve.

APPENDIX

Listing of Firms in the Sample by Calendar Year of Poor Price Performance

Firm	Year
Admiral Corporation	1956
Briggs Manufacturing Company	1956
Granby Consolidated Mining	1956
McCall Corporation	1956
Pfeiffer Brewing Company	1956
Philco Corporation	1956
Rheem Manufacturing Company	1956
Standard Coil Products Company	1956
Telautograph Corporation	1956
United Dye and Chemical Corporation	1956
United Park City Mines Company	1957
Allied-Albany Paper Corporation	1957
Briggs Manufacturing Company	1957
Bullard Company	1957
Butte Copper and Zinc Company	1957
Comptometer Corporation	1957
Copper Range Company	1957
Detroit Steel Corporation	1957
Howe Sound Company	1957
Industrial Rayon Corporation	1957
Magma Copper Company	1957
Penn-Texas Corporation	1957
Pittsburgh Steel Company	1957
Shahmoon Industries, Inc.	1957
United Dye and Chemical Corporation	1957
U. S. Hoffman Machinery Corporation	1957

Firm	Year
West Kentucky Coal Company	1957
Allied Products Corporation	1958
Chrysler Corporation	1958
De Vilbiss Company	1958
Fairbanks, Morse and Company	1958
Fenestra Incorporated	1958
I-T-E Circuit Breaker Company	1958
Lehigh Coal and Navigation Company	1958
Sun Oil Company	1958
United Biscuit Company of America	1958
Foote Mineral Company	1959
Getty Oil Company	1959
Jefferson Lake Sulphur Company	1959
National Can Corporation	1959
Temco Aircraft	1959
Texas Pacific Coal and Oil Company	1959
United Aircraft Corporation	1959
United Fruit Company	1959
Admiral Corporation	1960
Checker Motors Corporation	1960
Colorado Fuel and Iron Corporation	1960
Firth Carpet Company	1960
General Time Corporation	1960
I-T-E Circuit Breaker Company	1960
Lehigh Valley Industries, Incorporated	1960
New York Shipbuilding Corporation	1960
Rheem Manufacturing Company	1960
Studebaker-Packard Corporation	1960
United Industrial Corporation	1960
Adams-Millis Corporation	1961
Fenestra Incorporated	1961
General Baking Company	1961
General Dynamics Corporation	1961
General Portland Cement Company	1961

Firm	Year
Lionel Corporation	1961
Minnesota and Ontario Paper Company	1961
Natco Corporation	1961
Texas Instruments, Incorporated	1961
Universal Match Corporation	1961
Windsor Industries, Incorporated	1961
Brunswick Corporation	1962
Certain-teed Products Corporation	1962
Chris-Chraft Industries	1962
Foxboro Company	1962
Lionel Corporation	1962
Thompson (John R.) Company	1962
Universal Match Corporation	1962
Ward Industries Corporation	1962
Anken Chemical and Film Corporation	1963
Babbit (B.T.) Incorporated	1963
Brunswick Corporation	1963
Gamble-Skogomo, Incorporated	1963
Hoffman Electronics Corporation	1963
McCrory Corporation	1963
Melville Shoe Corporation	1963
Newberry (J.J.) Company	1963
Standard Kollsman Industries, Incorporated	1963
U. S. Industries, Incorporated	1963
Vendo Company	1963
Wheelabrator Corporator	1963
American Photocopy Equipment Company	1964
Anken Chemical and Film Corporation	1964
Electronic Associates, Incorporated	1964
High Voltage Engineering Corporation	1964
Indiana General Corporation	1964
Mattel, Incorporated	1964
Montecatini General Mining and Chemical Corporation	1964

Firm	Year
Mueller Brass Company	1964
Shahmoon Industries, Incorporated	1964
Thor Power Tool Company	1964
Benquet Consolidated	1965
Consolidated Cigar Corporation	1965
General Cigar Company, Incorporated	1965
General Portland Cement	1965
Hazeltine Corporation	1965
Marquette Cement Manufacturing Company	1965
Rayette-Faberge, Incorporated	1965
American Photocopy Equipment Company	1966
Arlan's Department Stores, Incorporated	1966
Central Foundry Company	1966
Consolidated Cigar Corporation	1966
International Pipe and Ceramics, Incorporated	1966
Marquette Cement Manufacturing Company	1966
Monsanto Company	1966
Screw and Bolt Corporation of America	1966
Thomasville Furniture	1966
Admiral Corporation	1967
American Broadcasting Companies, Incorporated	1967
NVF Company	1967
Sprague Electric Company	1967
Upjohn Company	1967
Automatic Sprinkler Corporation of America	1968
Bell and Howell Company	1968
Boeing Company	1968
Brown and Sharpe Manufacturing Company	1968
Corning Glassworks	1968
Fansteel, Incorporated	1968
Foxboro Company	1968
Freeport Sulphur Company	1968
General Dynamics Corporation	1968
Itek Corporation	1968

Firm	Year
Ling-Temco-Vought, Incorporated	1968
Maremont Corporation	1968
Sunstrand Corporation	1968
Victor Comptometer Corporation	1968
Dynamics Corporation of America	1969
General Host Corporation	1969
Gulf Resources and Chemical Corporation	1969
Hanes Corporation	1969
Ling-Temco-Vought, Incorporated	1969
Londontown Manufacturing Company	1969
National Industries, Incorporated	1969
Northwest Industries, Incorporated	1969
Seilon, Incorporated	1969
Simmonds Precision Products, Incorporated	1969
Villager Industries	1969
Electronic Memories and Magnetics Corporation	1970
Fairchild Camera and Instrument Corporation	1970
University Computing Company	1970
American Standard Incorporation	1971
Boise Cascade Corporation	1971
General Steel Industries	1971
International Mining	1971
Kaiser Aluminum and Chemical Corporation	1971
MacAndrews and Forbes Company	1971
Memorex	1971
Molybdenum Corporation of America	1971
Northgate Exploration Limited	1971
Technican Corporation	1971

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