FORMULA TIMING PLANS AND THE BETA COEFFICIENT: AN EMPIRICAL STUDY

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This is to certify that the

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presented by

Richard E. Williams

has been accepted towards fulfillment
of the requirements for

Ph.D. degree in Business - Finance

Alden C. Olson
Major professor

Date May 8, 1975

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ABSTRACT

FORMULA TIMING PLANS AND THE BETA COEFFICIENT: AN EMPIRICAL STUDY

By

Richard Edgar Williams

This thesis examined the investment performance of various formula plan strategies versus the buy-and-hold strategy during periods of cyclical stock price movements.

The beta coefficient was utilized both as a measure of risk and to develop the high- and low-risk portfolios that have been traditionally employed in formula plan operations. Twenty high-beta securities and twenty low-beta securities were selected from the two highest and the two lowest beta deciles respectively as compiled by Sharpe & Cooper[1] for the 1957-1961 period. As an alternative to low-beta stock, Treasury bills were also utilized in calculating formula plan performance.

Two types of formula plans were employed. One plan was of the constant-ratio variety in which the proportions invested in the high- and low-risk portfolios were rebalanced at quarterly intervals to 50%-50%. The other type of formula plan tested was of the variable-ratio

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[1] Sharpe, William F. and Cooper, Gary M. "Risk-Return Classes of New York Stock Exchange Common Stocks, 1931-1967," Financial Analysts Journal 28 (March-April, 1972): 46-54, 81, 95-101.

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type with the proportions invested in each portfolio changed as often as monthly depending on the level of the price-earnings ratio of the Standard & Poor's 500 Stock Index. The higher the price-earnings ratio, the larger was the proportion invested in the low-risk portfolio and vice-versa.

Performance was simulated in two ways, first by assuming an initial investment of $100 in each security and letting subsequent market action dictate the number of shares of each security that would be held. A one percent commission on all sales and purchases was used as a proxy for transaction costs. The ending value of the high- and low-risk portfolios was then calculated at the end of the 1962-1966, 1967-1971 and 1962-1971 periods. Secondly, monthly price relatives were calculated for each security. From these monthly price relatives a geometric mean for each plan in each of the three periods was derived using proportions invested in the low-risk and high-risk portfolios as weights.

The ending dollar and geometric mean returns for the formula plans were then compared with similar measures for four buy-and-hold portfolios which consisted of the low-beta portfolio, the high-beta portfolio, a portfolio combining the high- and low-beta portfolios in equal amounts, and the Standard & Poor's 500 Stock Index.

The results of the study indicate that the formula plans generally produced superior investment returns compared to the buy-and-hold portfolios during the three periods studied. When the results were adjusted for risk by calculating the Treynor Index, the conclusion that the formula plans generated superior returns relative to the buy-and-hold plans was further reinforced.

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Using the ending dollar value as a measure of performance, the formula plans did not produce as good a performance relative to the buy-and-hold plans after commissions as when the geometric mean was used as the performance measure. The relative decline in performance reflects primarily the substantial impact of commissions on the formula plans. However, even after commissions, the formula plans usually had a higher ending dollar value than the S&P 500 Index.

The efficiency of the formula plans, in the portfolio theory sense of reducing unsystematic risk, was not particularly good with correlation coefficients ranging from .703 to .779. The implication is that formula plan results are less predictable than results obtained from buy-and-hold portfolios. However, this result was expected since the formula plan portfolios used in the study were intended to produce performance different from the performance of the market as a whole.

The use of a sixty-month beta coefficient as the measure of risk worked reasonably well in that only one-fourth of the individual security betas moved out of their original risk class and most of these moves did not occur until the end of the ten-year period. Thus, the portfolio theory assumption of a stable portfolio beta over time is supported.

The results of this study also show that the use of a risk-free asset such as Treasury bills with a high-risk portfolio of stocks produced better results than when high- and low-beta stock portfolios were used. This finding suggests that using an extreme beta portfolio and leveraging with a risk-free asset can produce superior investment results.

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In sum, this study has demonstrated the usefulness of the formula plan as an investment timing device when proper attention is given to the risk-return characteristics of the portfolio securities.

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A THESIS

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ACKNOWLEDGMENTS

I wish to acknowledge my sincere appreciation to Dr. Melvin O'Connor and Dr. Robert Dolphin for their assistance and many helpful ideas which made the final version of this thesis much better than the original. Special thanks is owed to Dr. Alden Olson who, as Chairman of my thesis committee, worked closely with me from the very beginning and whose guidance and advice are greatly appreciated.

Of course, more appreciation than words can express is due my wife, Sharon, for her support, both moral and financial, without which this project would surely not have been completed.

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CHAPTER I

INTRODUCTION

Formula-timing plans originated in the 1940's as a reaction to the disastrous losses experienced by investors in the stock market collapse of 1929-1932. Prior to 1929 there had been wide acceptance of the theory that common stock prices would increase over time as the result of continued profitable reinvestment of earnings by corporations. This theory, popularized by Edgar Lawrence Smith (42), confirmed the belief of many investors that common stocks could be purchased as long-term investments at any level of the market. Careful timing of stock purchases was unnecessary, it was thought, as long as the securities were held for a sufficiently long period of time. However, the precipitous stock market crash which began in September, 1929 quickly dispelled the idea that timing was unimportant. Instead it was recognized that the level at which stocks are purchased and sold can have a major impact on the return earned by investors, especially when stock prices fluctuate cyclically around a secularly rising trend. Since the 1930's the problem of timing purchases and sales has received considerable attention in the popular literature of investments as evidenced by such titles as The Profit Magic of Stock Transaction Timing (25), How Charts Can Help You In the Stock Market (26), A Strategy of Daily Stock Market Timing for Maximum Profit (23), or Fundamentals for Profit in Undervalued Stocks (35), all of which, in one way or another, purport to show investo

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Formula-timing plans are investment strategies which attempt to make the timing decision automatically for the investor. That is, a plan or formula is devised which provides automatic buy or sell signals for the investor to follow. The general procedure is to make certain assumptions about the future trend of the market. Then, using these trend assumptions, a set of rules is constructed which has the investor sell stock as the market rises and invest the proceeds in a "defensive" portfolio of securities thus preserving the capital gains generated by the beginning portfolio. When the market turns down and declines below some pre-established level, the defensive securities are gradually sold and "aggressive" securities are purchased. In this context "defensive" is taken to mean the preservation of the value of the principal amount invested. That is, defensive securities are those with minimum financial risk which has been defined by Sauvain (43, pp. 128-29) as:

> ". . . . the uncertainty of a series of promised or expected cash receipts by owners of securities due to changes in the financial abilities of issuers to make payments to them, or due to changes in investors' estimates of their financial abilities."

Formula plan literature of the 1940's defined the defensive portfolio as consisting of spaced-maturity bonds with the implicit assumption being that bonds would not fluctuate in price because of changes in financial risk. By the same reasoning, common stock was considered an "aggressive" security in that purchase of common stock involved the risk that changes in the financial abilities of the issuing corporations or expectations about their abilities would cause fluctuations in the price of their stock.

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Cottle and Whitman (8) in their classic study of formula plans point out that all plans are characterized by (1) certain assumptions about the future; (2) the division of total portfolio assets into aggressive and defensive portions; and (3) the use of rules for systematic purchases and sales. It is the construction and use of these systematic rules which differentiate formula plans. Two general types of plans are usually discussed in investment textbooks, the constant-ratio plan and the variable-ratio plan. With constant-ratio plans a fixed percentage relationship between the bond and stock portions of the fund is maintained by periodic rebalancing. Consequently, as stock prices rise from the initial level (bond prices are presumed to remain constant) the percentage of stock value to bond value increases. After some predetermined time period has passed, or after some given percentage increase in a market index has taken place, stocks are sold and bonds purchased in sufficient quantity to restore the initial proportions. The same procedure, in reverse, is used when stock prices are falling.

Variable-ratio plans are more aggressive with respect to market fluctuations in that, as stock prices rise, the proportion of the total fund committed to stocks is continuously reduced until, assuming perfect timing, the fund is mostly invested in bonds at the peak of the market cycle. As stock prices fall the process is reversed, with stocks being purchased and bonds sold until, again assuming perfect timing, the fund is mostly invested in common stock at the bottom of the market cycle.

The specific trading rules used by constant and variable-ratio plans are too numerous to discuss here except to point out that one

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frequent modification of variable-ratio plans is to include a rising trend line around which stock prices are expected to fluctuate, thus allowing for a secular upward trend in stock prices. For a cataloging of the numerous possible types of trading rules see Persons (34) or Tomlinson (44).

Unfortunately for the users of most formula plans, the upward movement of stock prices in the 1950's was so strong and sustained that most plans performed poorly when compared with a buy-and-hold strategy, since there were few cyclical declines which could be used as an opportunity to rebalance the fund by purchasing stock. Indeed, most variable-ratio type plans found themselves completely or almost completely invested in a bond portfolio while the market continued to rise.[1] As a result, formula plans fell out of favor in the investment community and little has been written about them in the literature of the 1960's. The leading academic proponent of formula plans during the 1960's was Dince who, in a series of journal articles (9), (10), (11), suggested using a variable ratio plan in which the bond-stock ratio at any point in time was tied to a regression equation relating Gross National Product to the Dow Jones Industrial Average. The hypothetical DJIA computed from the regression equation was compared to the actual DJIA at quarterly intervals to see whether the market as a whole was over- or under-valued. This comparison determined the bond-stock proportions of the portfolio. Thus, if the actual DJIA was 141 percent or more above the regression formula value, the bond-stock proportions were

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[1]As Sauvain (43) p. 466, says: "The long bull market simply ran away from plans that assumed some cyclical ceiling, and investors who adhered to them were left in their minimum stock position."

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set at 80%-20%.[2] Dince's results indicated that $100,000 invested at the beginning of 1930 would have grown to $431,000 by the end of 1962. This amounted to a compounded annual return (including dividends) of 8.66 percent as compared with a buy-and-hold return on Moody's 125 Stock Average of 6.6 percent over the same period. Dince's work adds credence to the idea that formula plans need not always be outperformed by a buy-and-hold strategy given a reasonably accurate method for relating current stock prices to some type of "intrinsic" value.

Two developments in the investment environment of the later 1960's further suggest that the formula-timing idea should not be too quickly discarded. First, an examination of Figure I-1 shows that average stock prices over the 1960's went through three major cyclical declines of much greater severity than anything experienced during the 1946-1961 period, with the exception of the 1957 decline. Furthermore, it would appear that the strongly rising secular trend of the 1950's and early 1960's came to a halt during the six-year period from January 1966 to December 1971. By the end of this period the Standard and Poor's 500 Stock Index stood at virtually the same level as at the beginning.

Cyclical behavior of the kind experienced in the latter 1960's and early 1970's provides the sort of market environment in which formula plans should perform best. If the stock market continues to behave in this cyclical fashion in future years, formula plans may provide a better performance than the simple buy-and-hold strategy which worked so well in the 1953-1965 period. Fisher and Lorie (17), for example, found that an equal investment in all New York Stock

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[2] Dince (10), p. 685, Table IV.

FIGURE 1-1

STANDARD & POOR'S 500 STOCK INDEX, MONTHLY PRICES, 1946-1971

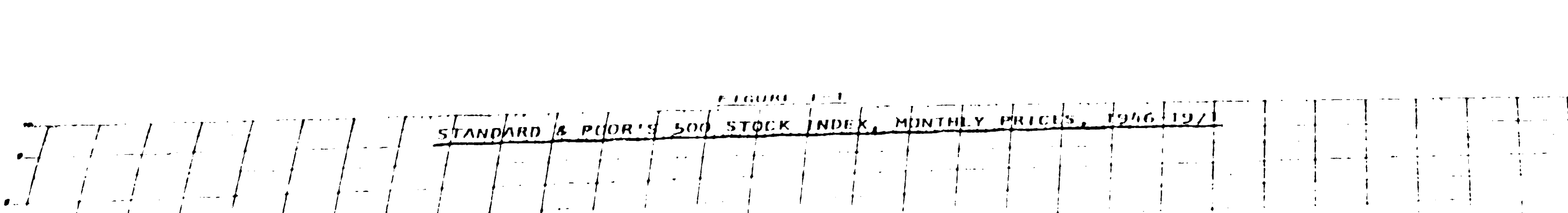
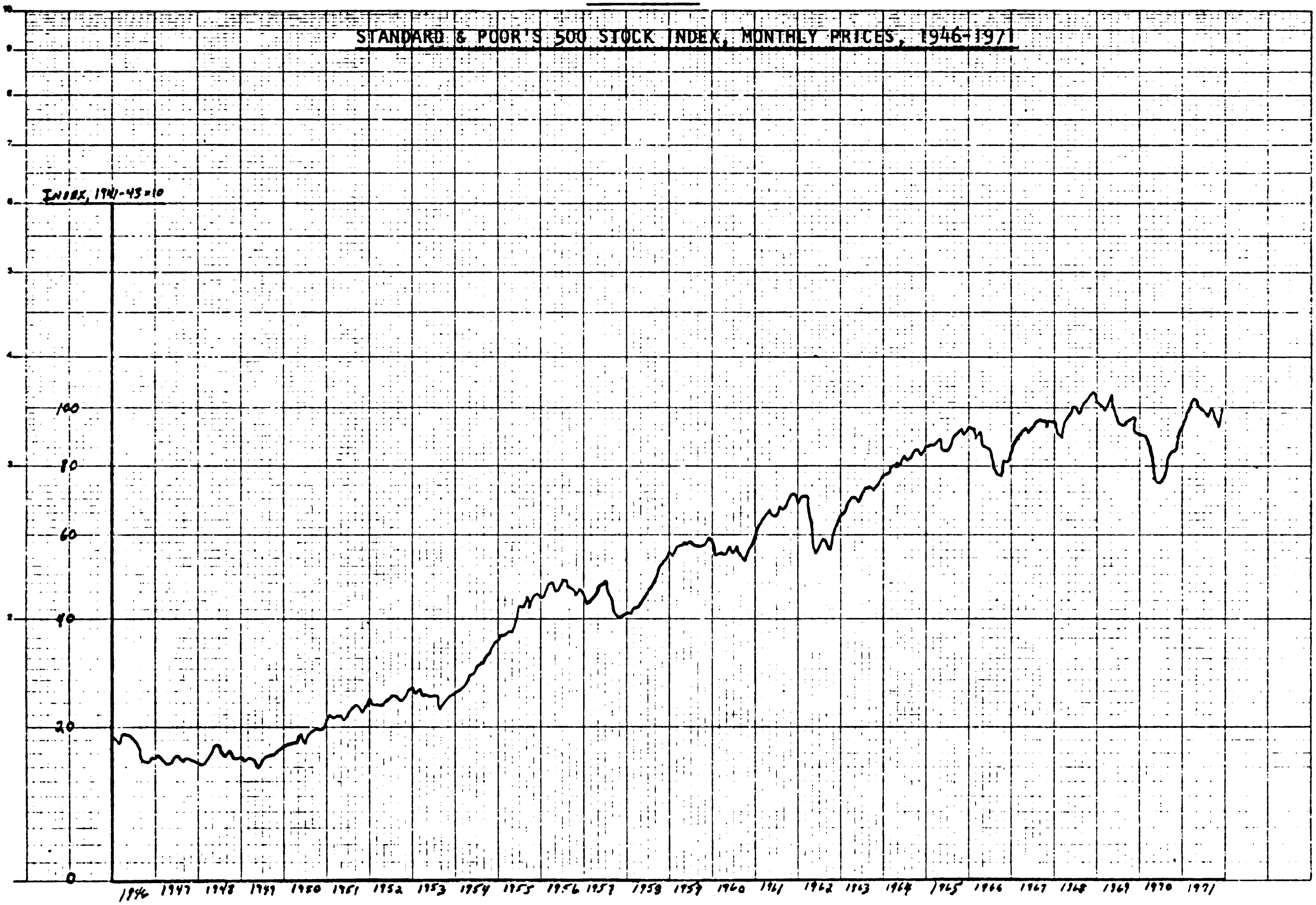


FIGURE 1-1

STANDARD & POOR'S 500 STOCK INDEX, MONTHLY PRICES, 1946-1971



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Exchange stocks bought at the end of 1953 and sold at the end of 1965 would have produced a tax-exempt return of 16.2 percent compounded annually.[3] On the other hand, holding the S&P 500 stocks during the 1966-1971 period would have resulted in virtually zero price appreciation and a dividend yield of only about 3.3 percent.

Secondly, the 1960's witnessed the development of a body of theoretical literature known as portfolio theory. This body of theory traces its origin back to a seminal article by Harry Markowitz (32) in 1952 which was subsequently refined and developed in a monograph published in 1959 (33). The full importance of Markowitz's work, however, was not recognized by the investment community until a series of articles by Sharpe (37), (38), (39), Lintner (31), and Treynor (45) revealed the implications of the Markowitz "efficient" diversification idea for the pricing of common stock and measurement of the performance of a portfolio of securities.

Essentially, the Markowitz-Sharpe-Treynor thesis contains the following propositions:

(1) Investors are, as a group, risk-averse and expect therefore to earn a higher return on a risky security than on a riskless one. Risk in this context is defined as interperiod variability of price plus dividends and measured as the variance or standard deviation around the expected return over some time period. The objective of investment management is taken to be the maximizing of expected return within the constraint of a risk-class specified by the

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[3]Fisher and Lorie (17), p. 7, Table 1.

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(2) Markowitz or "efficient" diversification consists of combining securities which have low correlation coefficients in such a way as to maximize the expected return of the portfolio for some given level of risk.

(3) The total risk of an individual security is made up of both "systematic" and "unsystematic" components. When combined in an efficient portfolio, however, the unsystematic risk component of the total portfolio risk can be reduced so as to approximate zero, leaving only the systematic risk component. Systematic risk cannot be similarly eliminated since it is the risk produced by such factors as changes in general economic conditions, interest rate levels or purchasing power which affect all securities to some extent. The investor, then, must choose some level of systematic risk within which he attempts to maximize return.

(4) Within a diversified portfolio of securities, the riskiness of an individual security can be measured by its systematic risk component (i.e. the variability of return of the security as compared with the variability of return for the market as a whole).

(5) Performance of a portfolio can be measured relatively by comparing excess return (i.e. portfolio return minus the risk-free interest rate) per unit of either systematic or total risk with that of other portfolios. The optimal portfolio is the one having the highest excess return per

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An implicit assumption of portfolio theory should be pointed out; namely the assumption that securities markets are perfect or at least efficient. Perfection in this context means that new information about a security is available to all investors and that such new information is rapidly if not instantaneously reflected in the price of the security. Since such information is presumed to enter the market in random fashion, security price changes will be random and independent of each other (14). A major conclusion to be drawn from this assumption is that prediction of future prices based on past information is of little value to the investor. When coupled with portfolio theory the implication for investors is that portfolio management can be reduced to an almost mechanical operation. Given estimates of the expected return and variability of a group of securities, the portfolio with the highest return for a given level of risk can be constructed by applying a quadratic programming model developed by Markowitz (33) or by using Sharpe's simpler diagonal model (37). The use of traditional security analysis techniques to discover undervalued issues is not relevant to this framework since all securities are already correctly priced according to their risk level. Buying an efficiently diversified portfolio of securities, given some level of risk, and earning a return commensurate with this risk level is the best that an investor without inside information can hope for. Francis (19), for example makes the following comments about the role of security analysis:

> Expert fundamental analysts who discover new financial information and quickly interpret it correctly will earn higher-than-average returns, but most fundamental analysts will not earn a return above

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> what could be achieved with a naive buy-and-hold strategy.[4]

In a similar vein, Francis comments on the role of the average investor:

> Selecting the most efficient portfolio in the preferred risk-class will enable the investor to attain his highest indifference curve in risk-return space. This investment may or may not earn an above-average rate of return - this depends on the risk-class the investor selects and when he liquidates his investment. But such analysis will maximize the investor's expected utility.[5]

Needless to say, the framework outlined above has not been completely accepted by practicing security analysts and portfolio managers trained in the intrinsic-value analysis methods of Graham and Dodd (22). There is, however, a growing body of literature, summarized by Fama in (15), which concludes that security markets are efficient enough to make the search for undervalued securities a fruitless occupation except for those individuals with exceptional insight or those having the time, data and computing equipment necessary for the type of highly sophisticated analysis which might give a temporary advantage over less knowledgeable investors. One aspect of portfolio management which, as yet, has received relatively little attention in the portfolio theory literature is the question of timing. The Markowitz-Sharpe models are static, one-period equilibrium models which show how to obtain an efficient portfolio at a point in time. The problem of transition from one period to the next as prices and investor expectations change and the initial portfolio becomes less and less efficient has not yet been

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[4]Francis (19), p. 547.

[5]Ibid., p. 548.

satisfactorily worked out in theory. Rather, most of the literature has concentrated on measuring returns over some holding period assuming a naive buy-and-hold policy in which the portfolio is left unchanged during the period. Recently, however, Evans (13) and Cheng and Deets (7), have shown that a policy of periodic rebalancing so as to maintain equal dollar amounts in each portfolio security produces better returns than the buy-and-hold policy. These studies along with those of Fisher and Lorie (17) and Brigham and Pappas (6), indicate that the timing of purchases and sales is in fact a major determinant of multi-period portfolio performance given cyclically fluctuating markets. Formula plans represent a timing device which make periodic timing decisions automatically and thus fit in well with the mechanistic approach to portfolio selection proposed by portfolio theory.

In order for formula plans to be successful it is necessary to forecast the trend and amplitude of stock prices with some accuracy. The failure of formula plans to perform well in the post-World War II era was a direct result of the failure by formula plan users to forecast the sustained bull market of that period. There is some question, however, whether future bull markets will be of the long and sustained nature experienced during the 1950's and early 1960's. Seligman (36), for example, has argued that inflation and the ending of several types of special market forces may usher in a "Bad New Era" for common stocks. According to Seligman, the relatively high levels of inflation experienced since 1965 have had the effect of both reducing corporate profit margins and raising interest rates. This has meant that the prices of common stocks declined for two reasons; first, by reducing expectations about future earnings; and secondly, by raising the discount rate that

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investors use to determine the present value of those future earnings. Seligman argues that the rate of inflation and interest rates will continue at relatively high levels throughout the 1970's, and therefore that the growth of common stock prices will continue to be less than the rate experienced during the 1953-1965 period. Furthermore, he argues that the relationship between the supply of and demand for common stock will be less favorable than in the past. On the supply side, corporations will continue the trend begun in 1969 of issuing large amounts of new stock. On the demand side both institutions and individual investors will reduce their purchases of common stock as high interest rates pull investment funds into the bond markets and as the institutions reach optimal bond/stock proportions in their portfolios.

Similarly, Bernstein (1) has argued that increased supply and reduced demand for common stock will make high rates of return less likely in the 1970's than in the 1960's. Grunewald and Klemkosky (24) have also argued that large stock market gains may be a thing of the past. Citing the special conditions which resulted in large earnings per share growth and price-earnings ratio increases during the 1950-1965 period as well as reduced liquidity in the stock market and the impact of wage and price controls on price-earnings ratios, they conclude that the stock market is likely to be more volatile in the future with a much lower secular growth rate. They point out that in such a market environment correct timing of purchases and sales becomes the key to successful investing and that formula plans are one type of timing device which could be used by investors to improve their investment returns.

In sum, the implication of the articles cited above is that stock price

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price trends in the future may be more amenable to the formula plan approach. Stock prices may continue to increase but the percentage increases may be much smaller than in the past and, more importantly for this thesis, price trends may be much more volatile as changes in the rate of inflation, interest rates, wage-price controls and corporate earnings all combine to cause waves of optimism and pessimism in the marketplace. Given this additional volatility and the corresponding increase in the necessity for better timing of purchases and sales, formula plans might once again come into widespread use by the investment community.

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CHAPTER II

RESEARCH DESIGN AND TECHNIQUE

Statement of Hypothesis

This thesis proposes to re-examine the formula plan concept in light of perceived changes in the market environment and using some of the newer analytical techniques developed in the literature as reviewed in Chapter I. Specifically, it is hypothesized that formula plans can earn a larger return than a buy-and-hold strategy without any additional increase in risk in a market environment characterized by cyclical fluctuations around a slowly rising trend line. This hypothesis will be tested by comparing the returns that would have been earned by a buy-and-hold strategy with the returns that would have been earned by several types of formula plans during the 1962-1971 period.

Research Design

Performance of the formula plans and the buy-and-hold policies will be simulated for the two non-overlapping five-year periods 1962-1966 and 1967-1971 as well as for the entire ten-year period 1962-1971. This time period was chosen for a number of reasons. First, during this ten-year period the stock market went through three major cycles. Standard & Poor's 500 Stock Index reached cyclical troughs in June 1962, October 1966 and June 1970. Cyclical peaks occurred in

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March 1962, January 1966 and December 1968. The cyclical nature of the stock market during this period provides the type of environment necessary for the successful operation of a formula plan. Second, formula plans have long time horizons and the five- and ten-year intervals being examined seem the minimum appropriate for testing the usefulness of formula plans as a portfolio management device. Third, the increase in the S&P 500 Stock Index from January 1962 until December 1971 averaged about 3.5 percent per year, the kind of increase that, it was argued in Chapter I, might be a reasonable expectation in future years.

Two types of formula plans will be tested: the constant-ratio type and the variable-ratio type. The specific trading rules employed by each were chosen on the basis of simplicity. The goal was to test formula plans that involved as few complex rules as possible in order to make application of the plans straightforward and to make the results as general as possible.

The constant-ratio plan is the simplest of all the formula plans in that no prediction about future market levels is necessary (except, of course, the assumption of cyclical movement in stock prices). Action points (i.e. points in time when the portfolio composition will be altered) in a constant-ratio plan can be based on some percentage change in a market average or they can be based on some time period. An example of the former would call for rebalancing the aggressive and defensive portfolios every time the market average rises or falls by say, ten percent. The latter type of constant-ratio plan and the type that will be used in this study is even simpler to operate, in that it calls for rebalancing the two portfolios after a fixed period of time witho

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without reference to the level of the market.

Variable-ratio plans, by contrast, are more difficult to develop since a market forecast is required. As a means of avoiding a prediction of the absolute level of the market, this study will use a variable-ratio plan in which action points are dictated by a change in the price-earnings ratio of a market average, the Standard & Poor's 500 Stock Index.

By incorporating the price-earnings ratio as a decision criterion, any secular increase in corporate earnings is taken into account by relating these earnings to the current market price index. An explicit forecast of market levels is not necessary. Rather, the assumption is made that the price-earnings ratio of the index will remain within a certain range and that action points in the formula plan can be constructed within that range.

Two versions of the constant-ratio plan and two versions of the variable-ratio plan will be tested. One constant-ratio plan will use a bond portfolio and a stock portfolio. The two portfolios will be rebalanced at quarterly intervals in order to maintain a market value ratio of 50 percent in each. In order to hold the risk of capital losses in the bond portfolio to zero, ninety-one day Treasury bills are assumed to be purchased at the beginning of the quarter and held until they mature. Treasury bills are used in place of the traditional portfolio of spaced maturity bonds in order to remove a major weakness of previous formula plans--namely, the assumption that bond prices would be stable over the life of the plan. Earlier plans did not recognize the problem of interest rate risk and the corresponding necessity of forecasting bond prices or investing in only short-term natu

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maturities in order to reduce this type of risk.

The stock portfolio will consist of New York Stock Exchange securities chosen from those in the two highest deciles of market sensitivity coefficients as of January 1, 1962 as compiled by Sharpe and Cooper (41). In this study, Sharpe and Cooper computed market sensitivity coefficients (i.e. the slope coefficient relating the capital gains returns on individual stocks to the capital gains returns on the market as a whole) for each year from 1931 to 1967 for all listed stocks on the New York Stock Exchange. The slope coefficients were based on monthly returns for the preceding five years. All the securities were then grouped into ten deciles according to the size of their coefficients during the preceding five-year period. This slope coefficient is analogous to the beta coefficient used in portfolio theory as a measure of the riskiness of an individual security in a portfolio. It differs only in that the beta coefficient relates the total return for each period, including dividends, to the total return on the market as a whole while the Sharpe-Cooper measure excludes dividends. Thus, a ranking of securities according to their market sensitivity coefficients is also a ranking of the securities according to their level of systematic risk.[6] Using securities from the two highest deciles of the Sharpe-Cooper study implies that highly volatile securities are being used in the aggressive portfolio of the formula plan. Consequently, the aggressive component of the total fund used

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[6]Because the market sensitivity coefficient and the beta coefficient are so similar, the high- and low-risk market sensitivity coefficient portfolios used in the formula plans will be referred to henceforth as the "high-beta" and "low-beta" portfolios respectively.

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in the plan assumes more risk than the stock portfolio usually seen in discussions of formula plans. Cottle and Whitman, Dince and others typically use the returns from a market index in computing formula plan results. When coupled with the defensive or bond portfolio, the total variability of the entire fund will be less than the market averages. It is not surprising then, that the return from formula plans is often found to be less than the return from a buy-and-hold policy, since, from a portfolio theory standpoint, less total risk is being assumed in the formula plan. By including only high-risk securities in the stock portfolio of this constant-ratio plan it is hoped that total variability will be comparable to the market as a whole and thus make comparisons with market averages more meaningful.

The second type of constant-ratio plan to be examined will continue to use the quarterly rebalancing technique. However, instead of using Treasury bills in the defensive portfolio, a portfolio of low-beta stocks will be utilized. This portfolio will be chosen from the two lowest deciles of the Sharpe-Cooper study. These securities, according to portfolio theory, are defensive in that their price changes over time are less than those of the market as a whole. Nevertheless, this plan is more aggressive with respect to financial risk than the other constant-ratio plan in that losses in the defensive portion of the total portfolio are now possible. The purpose of substituting stocks for bonds in the defensive portfolio is simply to examine the returns earned by an all-common stock plan as compared with the returns earned by the more traditional bond-stock plan given the same trading rules. Presumably, since the all-common stock plan is riskier, it should earn a higher return than the bond-stock plan.

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The third type of plan to be tested is a variable-ratio plan in which the ratio of the dollar investment in bonds to dollar investment in stock is dependent upon the level of the price-earnings ratio for the Standard & Poor's 500 Stock Index. Portfolio revision will occur only when the monthly price-earnings ratio moves from one level to another as shown in Table II-1.

TABLE II-1

PRICE-EARNINGS RATIO RANGES USED
IN VARIABLE-RATIO PLANS

P-E of S&P Index[1]	Defensive-Aggressive Ratio
14.0 or less	10%-90%
14.0-15.5	30%-70%
15.5-17.5	50%-50%
17.5-19.0	70%-30%
19.0 or more	90%-10%

[1]Yearly earnings for the most recent four quarters divided by the value of the Index at the end of the month.

The price-earnings ratio range of 14-19 was established after studying the range of the S&P 500 price-earnings ratio over the 1955-1961 period. During this period, the price-earnings ratio ranged from extremes of 11.78 in December 1957 to 22.18 in August 1961. Since both of these extremes occurred prior to the beginning of the time period used in this study, the range established in Table II-1 would have been a valid one to use during the period beginning January 1962. The median level is taken to be the range from 15.5-17.5. In actuality, the mean price earnings ratio for the S&P 500 Index during the 1962-1971 period was 17.2 with a high of 20.79 in February 1962 and

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and a low of 13.58 in June 1970. Thus the range shown in Table II-1 seems reasonable and is likely to be similar to the range in any future bull or bear markets unless there is a significant reappraisal by investors of the value of a dollar's worth of earnings.

As in the first constant-ratio plan, this plan will utilize a defensive portfolio consisting of Treasury bills and the aggressive portfolio will consist of the same high-beta securities. However, since portfolio readjustments can occur every month under this plan, thirty-day Treasury bills assumed to be purchased at the beginning of the month will be used instead of the 91-day bills of the constant-ratio plan in order to minimize the possibility of losses in the defensive portfolio.

The fourth and last formula plan to be tested is again of the variable-ratio type. Its operation is identical to that of the other variable-ratio plan described above except that the low-beta stock portfolio used in the second constant-ratio plan is substituted for the 30-day Treasury bills. This plan is the most aggressive of the four in that it keeps the fund fully invested in common stock at all times and relies on average price-earnings ratios to dictate the percentage of the fund invested in high-and low-risk securities. Unlike the traditional formula plan which utilized a defensive fund made up of bonds, this plan should lessen the risk of an improper market forecast since the fund will still be fully invested in common stock, albeit mostly low-risk, low-volatility stocks when the market is near a peak and in high-risk, high-volatility stocks when the market is near a cyclical low. The possibility of being entirely, or mostly, invested in bonds when the stock market was continuing to rise to new hig

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highs plagued earlier variable ratio plans and is avoided with this plan.

In addition, the substitution of a low-volatility portfolio of stock for a bond portfolio allows a test of the portfolio theory tenet that historically-derived low-beta stocks will provide less volatility than historically-derived high-beta stocks during cyclical swings in the market. If this proposition is true then the high-low beta portfolios should perform better than a policy of buying and holding a portfolio of stock with average price volatility since, during upswings of the market, low-beta stocks will be progressively substituted for high-beta stocks and vice-versa during downswings. Thus the large gains in price generated by the high-beta stocks as the market rises are preserved by transfering these gains into the low-beta portfolio. As the market moves down the more stable low-beta stocks are gradually replaced with high-beta stocks which have fallen more than the low-beta stocks and thus can be bought, on balance, at lower prices than the prices at which they were sold.

The above scenario will prove accurate only if the betas of high-beta stocks, whose coefficients have been calculated from historical data, remain relatively stable during the time period in which the formula plan is in operation. Instability of the beta coefficients during a market cycle would imply that high-beta stocks might become low-beta stocks during a market downturn. As a result, the formula plan results would be, at best, no better than the results to be attained by buying and holding an average-beta portfolio throughout the market cycle.

Fortunately, there is an accumulating body of empirical evidence whic

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which supports the stationarity property of the beta coefficient. At the level of the individual security, Blume (4) examined the stationarity of the beta coefficient for 251 securities over the 1927-1960 period. Individual security betas for six 7-year non-overlapping subperiods were regressed against the corresponding betas calculated for the subsequent subperiod. The average correlation coefficient was found to be about .72 which Blume interpreted in favor of the stationarity thesis.

Levy (30) calculated a 52-week beta coefficient for each of 500 New York Stock Exchange securities for each of the ten years 1961-1970. He compared each individual beta with the corresponding beta of the following year to test the ability of the current beta to predict the beta for the next period. Levy was thus able to correlate successive pairs of betas for each security for nine different periods. The quadratic mean of the nine correlation coefficients for individual securities was found to be .485.[7] However, when individual securities were combined into portfolios of 5, 10, 25 and 50 securities, correlation coefficients increased to .713, .815, .914 and .985 respectively.[8] Levy concludes:

> Evidence indicates that this risk measure is remarkably stationary for larger portfolios, less stationary for smaller portfolios and unpredictable for individual securities. Predictability improves materially as the forecast period lengthens. . . .(30, p. 62)

In a similar vein, Blume, in another study (5) found that 84-month individual beta coefficients calculated for portfolios of 20 and 50

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[7]Levy (30), p. 58.

[8]Ibid., p. 62.

securities exhibited considerable stationarity over time with product moment correlation coefficients of .92 and .98 respectively when the July 1954 to June 1961 period was compared with the July 1961 to June 1968 period.

The conclusion to be drawn from these studies can be summarized by saying that the stationarity property of the beta coefficient apparently increases as a function of both the time period over which beta is computed and the number of securities in the portfolio. For purposes of this study it will be assumed, based on the studies cited above, that a portfolio of high-beta securities and a portfolio of low-beta securities can be expected to remain high and low respectively over the 1962-1971 period under examination. However, as a precaution against the possibility that the beta coefficient of the securities used in this study might become unstable, the coefficients will be recalculated each year using the monthly returns for the preceding five years. That is, the securities used in the high- and low-beta portfolios at the beginning of the study are selected from the two highest and two lowest deciles of the Sharpe-Cooper study based on monthly price changes during the 1957-1961 period. This study will continually update this original data which ends with the coefficients for the 1962-1966 period so that, for example, new coefficients will be calculated in 1968 based on monthly returns from the preceding five-year period, 1963-1967. Thus a set of five market sensitivity coefficients will be calculated for each security for the overlapping five-year periods 1962-1966, 1963-1967, 1964-1968, 1965-1969, 1966-1970. This set of coefficients will indicate whether or not individual securities are maintaining their volatility level relative to other

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securities in the portfolio. Formula plan results will be calculated using the original securities throughout the ten-year test period. However, an attempt will also be made to keep the average beta of each portfolio at roughly its beginning level by substituting other high (low) volatility securities for those securities whose coefficient decreases (increases) be enough to move them out of their previous risk class. Thus, if a security's market sensitivity coefficient for the most recent sixty months should fall below the average of the Sharpe-Cooper risk-class nine (1.20), the security is assumed to be sold at the beginning of the year following the 60-month period for which the coefficient was calculated and replaced with another security whose coefficient has remained above 1.20. Similarly for the low-beta portfolio, substitution will occur when a security's market sensitivity coefficient rises above .75. Formula plan results will be calculated using this substitution method although it is expected that there will be little difference in the results since most of the securities in each beginning portfolio are expected to remain in their original risk class.

The high- and low-beta portfolios will each consist of twenty securities. Securities for each portfolio will be randomly selected from those available in the two upper and two lower Sharpe-Cooper risk-class deciles. In the process of selecting portfolio securities, only those securities which have shown previous risk-class stability--defined as having remained within two deciles of their 1962 decile level over the preceding ten years--will actually be used. Securities which are randomly selected but do not meet the test of stability will be discarded. Random selection will be continued in this fashion in

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until a total of twenty-five securities for each portfolio is selected. Five of these twenty-five (the last five chosen) will be used as substitute securities when any of the remaining twenty move out of their risk class.

The use of twenty securities in each portfolio was based partly on the beta-stationarity studies previously referenced, which indicated that a portfolio of twenty or more securities was likely to experience significant stability in the average beta over time. In addition, other studies have shown that a portfolio of this size is large enough to provide adequate diversification from the standpoint of eliminating unsystematic risk. Thus, Evans and Archer (12), Fisher and Lorie (18), and Latane and Young (29), have all concluded that 90-95 percent of all unsystematic variability of return can be eliminated with a portfolio of eight to fifteen randomly selected securities. Consequently, it is assumed that the twenty securities being used in each portfolio for this study will provide both a high degree of stability in the portfolio beta as well as providing enough diversification to eliminate most of the unsystematic risk component of the individual securities contained in the portfolios.

Technique

The performance of the four formula plans will be compared with the performance of four portfolios assumed to be purchased on either January 15, 1962 or January 15, 1967 and held until either December 15, 1966 or December 15, 1971. One of these buy-and-hold portfolios will be the Standard & Poor's 500 Stock Index, a widely used surrogate for the "market" in general. The other three buy-and-hold portfolios will co

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consist of (1) the twenty high-beta stocks; (2) the twenty low-beta stocks; and (3) a portfolio of the high- and low-beta stock portfolios combined in equal amounts. One reason for using the high-beta and low-beta portfolios is to test the portfolio theory idea that a high-risk portfolio should earn a higher return than the market portfolio over a long period of time. Similarly, the low-risk portfolio should be outperformed by both the market average and the high-risk portfolio.

Performance of the Standard & Poor's 500 Stock Index will be measured by computing a monthly geometric mean where the monthly price used in the price relative calculation is the monthly average price of the index. The geometric mean is defined as the nth root of the product of n monthly price relatives:

$$R_1 = \left[\prod_{i=1}^{n} (P_{i1}/P_{i-1,1} + D_{i1})\right]^{1/n} \tag{2.1}$$

where: i = 1------60 observations for the five-year periods 1962-1966 and 1967-1971 and
i = 1------120 observations for the 1962-1971 period.
P_{i1} = Value of the index for month i
$P_{i-1,1}$ = Value of the index for month i-1
D_{i1} = Dividend paid on the index during the period i-1 to i, expressed as a percentage of the index.

Performance of the high-beta, low-beta and equally-weighted buy-and-hold portfolios will be measured using a technique developed by Evans (13). Monthly prices for each security are taken as the closing price on the fifteenth of each month as reported in the ISL Daily Stock Price books and adjusted for stock splits and stock dividends. These prices are then used to calculate monthly price relatives for each security:

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2.2) $$R_{ij} = \frac{P_{ij} + D_{ij}}{P_{i-1,j}}$$

where: i = 1------60 or 120 observations
j = 1------20 or 40 securities
R_{ij} = Price relative for security j over period i-1 to i
P_{ij} = Price of security j at beginning of period i
$P_{i-1,j}$ = Price of security j at beginning of period i-1
D_{ij} = Dividend paid on security j over period i-1 to i.

For the buy-and-hold plans (except the S&P 500 Index) the equal dollar weighted compound return for each security will be calculated as:

(2.3) $$R_j = \prod_{i=1}^{m} R_{ij}$$

The portfolio geometric mean return is then given by:

(2.4) $$R_{BH} = (1/n \sum_{j=1}^{n} R_j)^{1/m}$$

where: R_{BH} = average geometric mean return for a portfolio of n securities over m monthly periods.

For example, assume a three-security portfolio with the price relatives shown in Table II-2.

TABLE II-2

RETURN MATRIX 1 FOR BUY-AND-HOLD CALCULATIONS

Security	Period Price Relatives				
	1	2	3	4	5
1	1.01	1.02	1.03	.99	1.01
2	.98	1.01	1.02	1.03	1.02
3	1.04	.96	1.05	.98	1.03

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If equal dollar amounts are invested in each security then, from equation 2.3:

$$R_1 = (1.01 \times 1.02 \times 1.03 \times .99 \times 1.01) = 1.0610$$
$$R_2 = (.98 \times 1.01 \times 1.02 \times 1.03 \times 1.02) = 1.0607$$
$$R_3 = (1.04 \times .96 \times 1.05 \times .98 \times 1.03) = 1.0581$$

From equation 2.4:

$$R_{BH} = [(1.061 + 1.0607 + 1.0581)/3]^{1/5}$$
$$R_{BH} = (1.0599)^{1/5}$$
$$R_{BH} = 1.0117$$

Thus, the monthly geometric mean for this five-month period is 1.17 percent.

Under the formula plan strategies, returns must be calculated for subperiods which vary from as little as one month to periods of several months in length. For the constant-ratio plans this subperiod is defined as a fixed interval of three months. Thus, over the ten-year period 1962-1971, there will be a total of 40 subperiods. For the variable-ratio plans, the length of the subperiods varies since the percentage composition of the aggressive and defensive portfolios will be changing according to the price-earnings ratio of the S&P 500 Index.

Within each subperiod two returns will be calculated, one for the low-risk portfolio (R_i^L) and one for the high-risk portfolio (R_i^H). For each portfolio the monthly return is calculated as:

(2.5) $$R_i = 1/n \sum_{j=1}^{n} R_j$$

where: R_i = average return in month i for a portfolio of n securities.

For the constant-ratio plan where the subperiods are fixed intervals of three months and the proportion invested in each portfolio is maintained at 50%-50%, the subperiod return (R_k) is the simple average of the monthly returns in each three-month subperiod for each portfolio.

(2.6) $$R_k = \frac{1/3\ (\sum_{i=1}^{3} R_i^L + \sum_{i=1}^{3} R_i^H)}{2}$$

where: R_i = Combined return in subperiod k for the low risk portfolio and the high-risk portfolio.

The portfolio geometric mean (R_{cr}) is then calculated as the nth root of the product of the p subperiod portfolio returns.

(2.7) $$R_{cr} = (\prod_{r=1}^{p} R_k)^{1/p}$$

For the variable-ratio plans the subperiods are variable in length and the proportions invested in the low-risk and high-risk portfolios change according to the price-earnings ratio of the S&P 500 Index. Thus the procedure for calculating the geometric mean is somewhat different than for the constant-ratio plans. The monthly return for each portfolio will still be calculated as in equation 2.5. However, the subperiod return--defined as the interval during which the proportions invested in the two portfolios remain unchanged--will be calculated as:

(2.8) $$R_z = \frac{P_r \sum_{i=1}^{z} R_i^L + P_s \sum_{i=1}^{z} R_i^H}{z}$$

where: z = number of months in subperiod k.
Pr = proportion of the total invested in the low-risk portfolio.
Ps = proportion of the total invested in the high-risk portfolio.
and $P_r + P_s$ = 100%

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Since the subperiods are of different length the geometric mean return for the entire five- or ten-year period must be weighted by the length of each subperiod.

$$(2.9) \qquad R_{vr} = \left(\prod_{z=1}^{q} z\, R_z\right)^{1/\Sigma z}$$

where: Σz = sum of the z subperiods of length q.

As an example of the variable-ratio calculation procedure, first assume the same returns matrix as shown in Table II-2 and, in addition, assume a second portfolio of three securities with period price relatives as shown in Table II-3.

TABLE II-3

RETURN MATRIX II FOR FORMULA PLAN CALCULATIONS

Security	Period Price Relatives				
	1	2	3	4	5
4	1.03	1.01	.98	1.02	1.00
5	1.01	1.03	.94	.98	1.01
6	1.05	1.04	.98	1.00	1.02

Secondly, assume that during periods one and two the price-earnings ratio of the S&P 500 calls for 70 percent of the total to be invested in the three securities comprising Return Matrix I and 30 percent in the three securities of Return Matrix II.

With these assumptions the price relative for the two months of the first subperiod would be calculated as:

$$R_1^L = \frac{1.01 + .98 + 1.04}{3} + \frac{1.02 + 1.01 + .96}{3} = 2.007$$

$$R_1^H = \frac{1.03 + 1.01 + 1.05}{3} + \frac{1.01 + 1.03 + 1.04}{3} = 2.057$$

$$R_z = \frac{.70(2.007) + .30(2.057)}{2}$$

$$R_z = \frac{1.049 + .6171}{2}$$

$$R_z = 1.0110$$

Now assume that in period 3 a change in the price-earnings ratio of the S&P 500 Index results in a change in the percentage composition of the two portfolios so that the total dollar investment is split--50 percent in each portfolio. A new subperiod thus begins and the weighted arithmetic return for subperiod 2 must be calculated.

$$R_2^L = \frac{1.03 + 1.02 + 1.05}{3} + \frac{.99 + 1.03 + .98}{3} + \frac{1.01 + 1.02 + 1.03}{3}$$

$$= 3.053$$

$$R_2^H = \frac{.98 + .94 + .98}{3} + \frac{1.02 + .98 + 1.00}{3} + \frac{1.00 + 1.01 + 1.02}{3}$$

$$= 2.978$$

$$R_z = \frac{.5(3.053) + .50(2.978)}{3}$$

$$R_z = \frac{1.5265 + 1.4890}{3}$$

$$R_z = 1.0052$$

The geometric mean return for the formula plan during these five months (two subperiods) is then calculated by:

$$R_{vr} = (2R_z \times 3R_z)^{1/5}$$

$$\log R_{vr} = \frac{2\log 1.011 + 3\log 1.0052}{5}$$

$$R_{vr} = 1.007515$$

Thus the monthly geometric mean for the five-month period is 0.7515 percent. Annualized over a 12-month period the return would be 9.40 percent (i.e. 1.007515^{12}).

Terminal dollar values for the four buy-and-hold plans and the four formula plans will also be calculated and reported with the geometric mean returns. It is recognized that the geometric mean return is a much better measure of a portfolio's performance over time than the ending dollar value of the portfolio. For one thing ending dollar value figures fail to take into account dividends received on the portfolio securities during the period studied. Secondly, the ending dollar value is a point in time value reflecting only the value of the portfolio as of the terminal date of the study; as a result, it says nothing about the value of or returns earned on the portfolio at intervening points in time. Nevertheless, the ending dollar value of a portfolio has the advantage of being easily understood. The ending value can be compared with the beginning value to see the absolute dollar magnitude of the capital gains realized during the period studied.

Transactions costs will be taken into account by assuming that a one percent commission would have been paid on all purchases and sales. The one percent figure was arrived at by examining a commission schedule for 1971 and noting that the commission paid on the sale or purchase of a round lot of a \$50 stock would approximate one percent of the stock's value. No attempt is made to calculate the exact commission on buying and selling stocks of varying prices since the fifty stocks used in this study vary in price from under \$10 per share to over \$100 per share and thus exact calculation of commissions would be very cumbersome. Rather, the commission on a \$50 stock is used to obtain a rough estimate of the magnitude of commissions that would actually be generated in a real world investment situation. The total commissions generated during each subperiod from rebalancing the aggressive and defensive portfolios are deducted from the total market value of the two portfolios and this reduced amount then becomes the beginning value for the next subperiod. Terminal values for each formula plan using this method of accounting for transaction costs will be reported along with the terminal values before considering transaction costs. In this way the effect of transaction costs on the formula plan results can be readily compared with the transaction costs associated with the buy-and-hold plans.

The question of whether the various formula plans and buy-and-hold portfolios attained their return because of differences in the amount of risk assumed will be analyzed by using the Treynor Index (45). This index computes the excess return on the portfolio in question per unit of systematic risk. The formulation is:

$$T = \frac{R_{ip} - R_f}{B_{ip}}$$

where: R_{ip} = return on portfolio p during period i expressed as an annualized monthly geometric mean.

R_f = risk-free rate of interest over the portfolio time horizon. The proxy for This rate will be the average interest rate on intermediate-term government bonds at the beginning of 1962 and 1967 and the average interest on long-term government bonds at the beginning of 1962.

B_{ip} = weighted average beta of portfolio p during period i.

Sharpe in (40) has shown that a weighted average of individual betas multiplied by the variance of the market index provides a good measure of the riskiness of an efficiently diversified portfolio. That is:

$$B_{ip} = \sum_{j=1}^{m} x_j b_j$$

and $$\sigma_p^2 = \beta_{ip} \, \sigma_I^2$$

Since the market variance is a constant for any security or portfolio, the weighted average of the individual betas may be used to measure the ex-post risk of a diversified portfolio.

CHAPTER III

ANALYSIS OF RESULTS

Summary

This chapter reports the results obtained from simulating the performance of the four types of formula timing plans described in Chapter II. As an aid to the reader a summary of the chapter is provided before the detailed results are reported. It should be pointed out that for each type of formula plan two sets of results for three time periods were calculated. For each formula plan in each of the three time periods, results were obtained using portfolios of common stock in which the component securities were left unchanged throughout the period. For clarity of exposition these results will be referred to henceforth as "unadjusted beta" portfolio results, referring to the fact that the securities were selected based on their volatility at the beginning of 1962 and no substitution of other securities was made to adjust for changes in their beta coefficients over time. Results were also obtained for each formula plan using portfolios in which some substitution of securities was made to allow for the fact that some securities in the low- and high-beta portfolios did shift out of their relative risk-class during the time period studied. This substitution procedure is explained in more detail in Appendix A. Formula plans in which substitution took place will be referred to as "adjusted beta" portfolio results.

A major conclusion to be drawn from the results is that the formula plans tested demonstrated superior performance relative to buying and holding the "market" as represented by the Standard & Poor's 500 Stock Index. As shown in Tables III-1a, III-1b, and III-1c all of the formula plan portfolios produced higher ending dollar values after allowing for a one percent commission on all purchases and sales than the S&P 500 in the 1962-1966 and 1962-1971 periods. However, in the 1967-1971 period the S&P 500 produced higher ending dollar values than any of the unadjusted beta portfolios. For all time periods covered, the monthly geometric means (calculated before commissions) of the formula plans were substantially higher than the geometric mean of the S&P 500. Such comparisons, of course, do not allow for differences in volatility between the market portfolio and the formula plan portfolios. Volatility differences are taken into account in calculating the Treynor Index which measures the excess return on the portfolio per unit of market risk assumed. As shown in Tables III-1a, III-1b, and III-1c the Treynor Index was, with one exception, always higher for the formula plan portfolios than for the S&P 500 when the annualized monthly geometric mean is used as the basis for measuring return on the portfolios.

In addition to the S&P 500, results were also simulated for three other buy-and-hold portfolios. These portfolios consisted of the low-beta portfolio used in the unadjusted beta formula plans, the high-beta portfolio from the same plans and a portfolio made up of both the high- and low-beta portfolios with equal investment in each. This plan is denoted as the "Equally-Weighted" buy-and-hold plan in the tables. Comparison of the results from these buy-and-hold portfol

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portfolios with the formula plan results presents a somewhat mixed picture.

As might be expected from portfolio theory, the high-beta buy-and-hold portfolio produces higher ending dollar values after adjustment for commissions than any of the formula plans in the 1962-1966 and 1962-1971 periods. However, in the 1967-1971 period, the adjusted-beta formula plans produced higher ending dollar values while the unadjusted-beta portfolios performed about the same. Again, however, comparison of the formula plan results with the high-beta buy-and-hold plan does not allow for differences in portfolio volatility. As the Treynor Index numbers in Tables III-1a, III-1b, and III-1c, indicate, the formula plans produced higher returns per unit of market risk. This was true for all periods in cases where the formula plans consisted of high-beta stock portfolios and Treasury bills. When the formula plan used high- and low-beta stock portfolios, the results were mixed with the variable-ratio plans always outperforming the high-beta buy-and-hold and constant-ratio plans usually outperforming the high-beta portfolio.

Finally, comparing the equally-weighted buy-and-hold portfolio with the formula plans leads to conclusions somewhere between those generated by comparing the high-beta buy-and-hold portfolio with the formula plans and those produced when the S&P 500 is compared with the formula plan results. That is, the equally-weighted buy-and-hold plan generated higher dollar returns than the S&P 500 portfolio but smaller dollar returns and geometric mean returns than the high-beta buy-and-hold plan. This result would have been expected considering that the average beta level of the equally-weighted portfolio lies between that of the high-beta portfolio and the S&P 500 portfolio.

Within the formula plans themselves, three conclusions stand out. First, it is apparent from Table III-2 that the variable-ratio plans usually did not perform better than the comparable constant-ratio plans. This conclusion is somewhat unexpected from the nature of the two types of plans since more high-beta stock should be bought at low prices and sold at high prices with the variable-ratio plan than with the constant-ratio plan. Secondly, Table III-3 indicates that adjusting beta levels, at least in the limited manner employed in this study, did not improve on average, and, in fact, worsened the performance of the formula plans. In eight out of twelve comparisons the geometric mean of the constant-ratio plans was higher than that of the comparable variable-ratio plans. Third, it was clear from the results that the variable-ratio plans using Treasury bills were superior to the variable-ratio plans which used low-beta stock. Table III-4 shows that the formula plans using Treasury bills as the low-risk portfolio consistently performed better than the formula plans using a low-beta stock portfolio. This result may be biased by the particular low-beta sample chosen and the time period studied. Nevertheless, on a risk-adjusted basis, performance of the low-beta portfolio would have to be significantly better than the results reported here in order to make up for the increase in the average beta of the portfolio which occurred when low-beta stocks were substituted for Treasury bills.

As a general observation it should be pointed out that the geometric mean return provides a better measure for ranking performance than ending dollar value because it measures <u>total</u> return, including both dividends and capital gains, over the entire period whereas the dollar value figures measure only capital gains at a point in time. Thus the validity of the conclusions drawn in this chapter and the next should be based primarily on the geometric mean returns reported. The ending dollar value results are presented only as a secondary guage of the performance of the portfolios studied and to give the reader some idea of the magnitude of the dollar capital gains that would have been earned during the periods studied on the various types of formula and buy-and-hold plans.

The remainder of this chapter presents more detailed results for the constant-ratio plan during the 1962-1966, 1967-1971 and 1962-1971 periods followed by the results for the variable-ratio plans over the same three periods.

TABLE III-1a

COMPARATIVE RESULTS, 1962-1966

Type of Plan	Ending Dollar Value* Before Comm.	Ending Dollar Value* After Comm.	Monthly Geo. Mean	Annualized Geo. Mean	Ave. Beta	Treynor** Index
Constant-Ratio Unadjusted Betas W/ Treasury Bills	$5519	$5438	1.0149	19.42%	.918	.1820
Constant-Ratio Adjusted Betas W/ Treasury Bills	$5395	$5311	1.0108	13.76%	.955	.1366
Constant-Ratio Unadjusted Betas W/ Low-Beta Stock	$5336	$5244	1.0094	11.88%	1.229	.0949
Constant-Ratio Adjusted Betas W/ Low-Beta Stock	$5288	$5189	1.0067	8.34%	1.235	.0877
Variable-Ratio Unadjusted Betas W/ Treasury Bills	$6142	$5810	1.0124	15.94%	.679	.2927
Variable-Ratio Adjusted Betas W/ Treasury Bills	$6147	$5810	1.0101	12.82%	.707	.2383
Variable-Ratio Unadjusted Betas W/ Low-Beta Stock	$5952	$5328	1.0108	13.76%	1.071	.1269
Variable-Ratio Adjusted Betas W/ Low-Beta Stock	$6013	$5377	1.0101	12.82%	1.059	.1753
Buy & Hold Low-Beta Stock	$3848	$3808	1.0037	4.53%	.622	.0347
Buy & Hold High-Beta Stock	$7632	$7592	1.0124	15.94%	1.836	.0941
Buy & Hold Equally Weighted High & Low Beta	$5740	$5700	1.0080	10.03%	1.229	.0938
Buy & Hold S&P 500 Index	$4710	$4670	1.0060	7.44%	1.000	.0331

*Beginning Value for each plan was $4000.
**The risk-free rate used in computing the Treynor Index for this period was 4.13%.

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TABLE III-1b

COMPARATIVE RESULTS, 1967-1971

Type of Plan	Ending Dollar Value* Before Comm.	Ending Dollar Value* After Comm.	Monthly Geo. Mean	Annualized Geo. Mean	Ave. Beta	Treynor** Index
Constant-Ratio Unadjusted Betas W/ Treasury Bills	$4543	$4468	1.0100	12.68%	.945	.0463
Constant-Ratio Adjusted Betas W/ Treasury Bills	$5173	$5069	1.0114	14.57%	1.002	.0698
Constant-Ratio Unadjusted Betas W/ Low-Beta Stock	$4481	$4402	1.0069	8.47%	1.280	.0291
Constant-Ratio Adjusted Betas W/ Low-Beta Stock	$5098	$4980	1.0070	8.73%	1.277	.0414
Variable-Ratio Unadjusted Betas W/ Treasury Bills	$4846	$4578	1.0076	9.51%	.894	.0664
Variable-Ratio Adjusted Betas W/ Treasury Bills	$5528	$5209	1.0083	10.43%	.948	.1064
Variable-Ratio Unadjusted Betas W/ Low-Beta Stock	$4526	$4042	1.0053	6.55%	1.247	.0340
Variable-Ratio Adjusted Betas W/ Low-Beta Stock	$5302	$4706	1.0076	9.51%	1.238	.0478
Buy & Hold Low-Beta Stock	$3962	$3922	1.0049	6.04%	.671	.0117
Buy & Hold High-Beta Stock	$4506	$4466	1.0039	4.78%	1.889	.0321
Buy & Hold Equally Weighted High & Low Beta	$4234	$4194	1.0044	5.41%	1.280	.0150
Buy & Hold S&P 500 Index	$4697	$4657	1.0054	6.68%	1.000	.0206

*Beginning Value for each plan was $4000.
**The risk-free rate used in computing the Treynor Index for this period was 4.61%.

TABLE III-1c

COMPARATIVE RESULTS, 1962-1971

Type of Plan	Ending Dollar Value* Before Comm.	Ending Dollar Value* After Comm.	Monthly Geo. Mean	Annualized Geo. Mean	Ave. Beta	Treynor** Index
Constant-Ratio Unadjusted Betas W/ Treasury Bills	$6638	$6464	1.0124	15.94%	.931	.0964
Constant-Ratio Adjusted Betas W/ Treasury Bills	$7494	$7251	1.0111	14.16%	.979	.0807
Constant-Ratio Unadjusted Betas W/ Low-Beta Stock	$6461	$6298	1.0081	10.16%	1.255	.0482
Constant-Ratio Adjusted Betas W/ Low-Beta Stock	$7389	$7171	1.0069	8.60%	1.260	.0543
Variable-Ratio Unadjusted Betas W/ Treasury Bills	$8030	$7173	1.0109	13.89%	.785	.1612
Variable-Ratio Adjusted Betas W/ Treasury Bills	$9319	$8296	1.0092	11.62%	.825	.1669
Variable-Ratio Unadjusted Betas W/ Low-Beta Stock	$7306	$5909	1.0076	8.51%	1.159	.0891
Variable-Ratio Adjusted Betas W/ Low-Beta Stock	$8861	$7061	1.0089	11.22%	1.146	.0877
Buy & Hold Low-Beta Stock	$3900	$3860	1.0043	5.28%	.647	.0200
Buy & Hold High-Beta Stock	$9301	$9261	1.0082	10.30%	1.862	.0511
Buy & Hold Equally Weighted	$6600	$6560	1.0062	7.70%	1.255	.0545
Buy & Hold S&P 500 Index	$5743	$5703	1.0057	7.06%	1.000	.0299

*Beginning Value for each plan was $4000.
**The risk-free rate used in computing the Treynor Index for this period was 4.10%.

TABLE III-2

COMPARISONS BETWEEN CONSTANT & VARIABLE RATES

TABLE III-2

COMPARISONS BETWEEN CONSTANT & VARIABLE-RATIO PLAN RESULTS, ANNUALIZED GEOMETRIC MEAN AND ENDING TOTAL DOLLAR VALUE

	1962-1966		1967-1971		1962-1971	
	Geo. Mn.	$ Value	Geo. Mn.	$ Value	Geo. Mn.	$ Value
Constant-Ratio Unadjusted Betas W/ Treasury Bills	19.42%	$5438	12.68%	$4468	15.94%	$6464
Variable-Ratio Unadjusted Betas W/ Treasury Bills	15.94%	$5810	9.51%	$4578	8.60%	$7173
Constant-Ratio Adjusted Betas W/ Treasury Bills	13.76%	$5311	14.57%	$5069	14.16%	$7251
Variable-Ratio Adjusted Betas W/ Treasury Bills	12.82%	$5810	10.43%	$5209	11.62%	$8296
Constant-Ratio Unadjusted Betas W/ Low-Beta Stock	11.88%	$5244	8.47%	$4402	10.16%	$6298
Variable-Ratio Unadjusted Betas W/ Low-Beta Stock	13.76%	$5328	6.55%	$4042	9.51%	$5909
Constant-Ratio Adjusted Betas W/ Low-Beta Stock	8.34%	$5189	8.73%	$4980	8.60%	$7171
Variable-Ratio Adjusted Betas W/ Low-Beta Stock	12.82%	$5377	9.51%	$4706	11.22%	$7061

TABLE III-3

COMPARISONS BETWEEN UNADJUSTED-BETA AND ADJUSTED-BETA PORTFOLIO RESULTS, ANNUALIZED GEOMETRIC MEAN AND ENDING TOTAL DOLLAR VALUE

Type of Plan	1962-1966		1967-1971		1962-1971	
	Geo. Mn.	$ Value	Geo. Mn.	$ Value	Geo. Mn.	$ Value
Constant-Ratio Unadjusted Betas W/ Treasury Bills	19.42%	$5438	12.68%	$4468	15.94%	$6464
Constant-Ratio Adjusted Betas W/ Treasury Bills	13.76%	$5311	14.57%	$5069	14.16%	$7251
Constant-Ratio Unadjusted Betas W/ Low-Beta Stock	11.88%	$5244	8.47%	$4402	10.16%	$6298
Constant-Ratio Adjusted Betas W/ Low-Beta Stock	8.34%	$5189	8.73%	$4980	8.60%	$7171
Variable-Ratio Unadjusted Betas W/ Treasury Bills	15.94%	$5810	9.51%	$4578	13.89%	$7173
Variable-Ratio Adjusted Betas W/ Treasury Bills	12.82%	$5810	10.43%	$5209	11.62%	$8296
Variable-Ratio Unadjusted Betas W/ Low-Beta Stock	13.76%	$5328	6.55%	$4042	9.51%	$5909
Variable-Ratio Adjusted Betas W/ Low-Beta Stock	12.82%	$5377	9.51%	$4706	11.22%	$7061

TABLE III-4

COMPARISON OF RESULTS BETWEEN FORMULA PLANS USING TREASURY BILLS AND FORMULA PLANS USING LOW-BETA STOCK PORTFOLIO, ANNUALIZED GEOMETRIC MEAN AND ENDING DOLLAR VALUE

Type of Plan	1962-1966		1967-1971		1962-1971	
	Geo. Mn.	$ Value	Geo. Mn.	$ Value	Geo. Mn.	$ Value
Constant-Ratio Unadjusted Betas W/ Treasury Bills	19.42%	$5438	12.68%	$4468	15.94%	$6464
Constant-Ratio Unadjusted Betas W/ Low-Beta Stock	11.88%	$5244	8.47%	$4402	10.16%	$6298
Constant-Ratio Adjusted Betas W/ Treasury Bills	13.76%	$5311	14.57%	$5069	14.16%	$7251
Constant-Ratio Adjusted Betas W/ Low-Beta Stock	8.34%	$5189	8.73%	$4980	8.60%	$7171
Variable-Ratio Unadjusted Betas W/ Treasury Bills	15.94%	$5810	9.51%	$4578	13.89%	$7173
Variable-Ratio Unadjusted Betas W/ Low-Beta Stock	13.76%	$5328	6.55%	$4042	9.51%	$5909
Variable-Ratio Adjusted Betas W/ Treasury Bills	12.82%	$5810	10.43%	$5209	11.62%	$8296
Variable-Ratio Adjusted Betas W/ Low-Beta Stock	12.82%	$5377	9.51%	$4706	11.22%	$7061

Constant-Ratio Plan Results

1962-1966

None of the constant-ratio plans performed better than the equally-weighted buy-and-hold strategy during the 1962-1966 period although they all outperformed the S&P 500. As shown in Table III-5, the total dollar value of the four constant-ratio plans was less than that of the equally-weighted buy-and-hold strategy, even before commissions are considered. After allowing for commissions of one percent on purchases and sales, the constant-ratio plans produced ending dollar values from \$262 to \$511 less than the buy-and-hold plan. In percentage terms, the buy-and-hold strategy outperformed the constant-ratio plans by from 6.6 percent to 12.8 percent based on initial investment of \$4000 in each plan. The constant-ratio plan using unadjusted high-beta stocks and Treasury bills produced considerably better total dollar and geometric mean results than did the comparable unadjusted high- and low-beta constant-ratio plan. Most of the difference can be attributed to the poor performance of the low-beta stock portfolio. This portfolio, on a buy-and-hold basis ended the five-year period with a total value of only \$3848 before commissions compared to a beginning value of \$4000. Since the low-beta portfolio consisted largely of electric and gas utility stocks, the reason for the poor performance of this portfolio during a period of generally rising stock prices is primarily due to the heightening concern over inflation and the impact of higher interest rates on utility earnings that was becoming apparent by 1966. Consequently, by year-end 1966 the prices of most of the utility stocks in the low-beta portfolio were less than at the beginning of 1962 when utility stocks were still

TABLE III-5

COMPARATIVE RESULTS - CONSTANT-RATIO PLANS, 1962-1966

Type of Plan	Ending Dollar Value* Before Comm.	After Comm.	Monthly Geo. Mean	Annualized Geo. Mean	Ave. Beta	Treynor Index
Unadjusted Betas W/ Treasury Bills	$5519	$5438	1.0149	19.42%	.918	.1820
Unadjusted Betas W/ Low-Beta Stock	$5336	$5244	1.0094	11.88%	1.229	.0949
Adjusted Betas W/ Treasury Bills	$5395	$5311	1.0108	13.76%	.955	.1366
Adjusted Betas W/ Low-Beta Stock	$5288	$5189	1.0067	8.34%	1.235	.0877
Buy-and-Hold Low-Beta Stock	$3848	$3808	1.0037	4.53%	.622	.0347
Buy-and-Hold High-Beta Stock	$7632	$7595	1.0124	15.94%	1.836	.0941
Buy-and-Hold Equally Weighted High & Low Betas	$5740	$5700	1.0080	10.03%	1.229	.0938
Buy-and-Hold S&P 500 Index	$4710	$4670	1.0060	7.44%	1.000	.0331

*Beginning Value for each plan was $4000.

viewed as slow but steady "growth" vehicles. The monthly geometric mean return for the low-beta portfolio was positive, averaging 0.37 percent per month (4.53 percent annually), only because of the relatively high dividend that these stocks were paying.

Although the constant-ratio plans did not outperform the equally-weighted buy-and-hold plan utilizing the same securities as used in the formula plan portfolios, they did outperform the market as measured by the S&P 500 Stock Index. In total dollars this superior return amounted to from \$519 to \$868 over the five-year period or, in percentage terms, differences of from 13.0 percent to 19.2 percent based on the initial investment of \$4000 in each plan. In terms of the geometric mean, the constant-ratio plans averaged 13.35 percent annually for the four plans compared to the 7.44 percent return of the S&P 500. In the case of plans using two portfolios of stock, however, this superior performance was achieved only at the expense of greater risk exposure. The average beta coefficient for the unadjusted and adjusted-beta plans was 1.229 and 1.235 respectively compared to 1.0 for the S&P 500. On the other hand, the constant-ratio plans utilizing high-beta stocks and Treasury bills produced equally superior performance over the market index but with a lower risk level as indicated by the average beta levels of .918 and .955 for the adjusted and unadjusted-beta plans.

To put the risk-return levels of the various plans in perspective, Table III-5 shows the Treynor Index for all four formula plans as well as for the buy-and-hold plans. As might be expected the high-beta/Treasury bill plans with their lower average beta produced substantially higher Treynor Index numbers than the formula plans using two portfolios of stock or the buy-and-hold plans.

1967-1971

The performance of the constant-ratio plans during the 1967-1971 period was inferior to their performance during the previous five years. Table III-6 shows that total ending dollar values after commissions and geometric mean returns of all the constant-ratio plans were above those of the equally-weighted buy-and-hold plan. However, only two of the plans, those using adjusted-beta stock portfolios, performed better than the S&P 500. The two unadjusted-beta plans performed somewhat worse in terms of ending dollar value although all four plans again outperformed the S&P 500 in terms of geometric mean return. This pattern of returns represents a reversal from the previous five-year period when both the formula plans and the equally-weighted buy-and-hold plan performed better than the S&P 500.

The stock market during this period was characterized by wide swings in the prices of securities, including one prolonged bear market in which the S&P 500 Stock Index fell from a level of 106.50 in December 1968 to 75.59 in June 1970. By the end of the period, December 1971, the S&P 500 had recovered to a level of 99.17. This recovery was not nearly as apparent, however, in the prices of the securities used in the formula plans and the buy-and-hold portfolios. Over the entire five-year period the S&P 500 Index rose by 17.43 percent. In contrast, the value of the high-beta portfolio rose only 12.65 percent and the low-beta portfolio declined by 0.95 percent. Ten of the twenty securities included in the unadjusted high-beta portfolio were selling at lower prices in December 1971 than at the beginning of

TABLE III-6

COMPARATIVE RESULTS - CONSTANT-RATIO PLANS, 1967-1971

Type of Plan	Ending Dollar Value* Before Comm.	After Comm.	Monthly Geo. Mean	Annualized Geo. Mean	Ave. Beta	Treynor Index
Unadjusted Betas W/ Treasury Bills	$4553	$4468	1.0100	12.68%	.945	.0463
Unadjusted Betas W/ Low-Beta Stock	$4481	$4402	1.0068	8.47%	1.280	.0291
Adjusted Betas W/ Treasury Bills	$5173	$5069	1.0114	14.57%	1.002	.0698
Adjusted Betas W/ Low-Beta Stock	$5098	$4980	1.0070	8.73%	1.277	.0414
Buy-and-Hold Low-Beta Stock	$3962	$3922	1.0049	6.04%	.671	.0117
Buy-and-Hold High-Beta Stock	$4506	$4466	1.0039	4.78%	1.889	.0321
Buy-and-Hold Equally Weighted High & Low Betas	$4234	$4194	1.0044	5.41%	1.280	.0150
Buy-and-Hold S&P 500 Index	$4967	$4657	1.0054	5.58%	1.000	.0206

*Beginning Value for each plan was $4000.

1967, while eleven of the twenty low-beta securities were selling at lower prices at the end of the period than at the beginning. A more revealing comparison of the 1962-1966 and 1967-1971 periods is provided in Table III-7 which classifies securities in the unadjusted low- and high-beta portfolios according to their price change from the beginning of each period to the end of the period.

Table III-7 sheds some light on the relatively better performance of the constant ratio plans and equally-weighted buy-and-hold plan compared with the S&P 500 during the 1962-1966 period. The performance of the low-beta portfolio in both periods is roughly comparable, with the earlier period having a large number of stocks selling at lower prices in 1966 than at the beginning of 1962. For the high-beta portfolio, however, there were a larger number of stocks showing

TABLE III-7

PRICE CHANGE COMPARISONS BETWEEN INDIVIDUAL STOCKS IN LOW-BETA AND HIGH-BETA PORTFOLIOS, 1962-1966 vs 1967-1971

	Beginning Price			
	More than 50% above beginning	0-50% above beginning	0-20% below beginning	More than 20% below beginning
Low-Beta Portfolio				
1962-1966	0	7	10	3
1967-1971	1	8	6	5
High-Beta Portfolio				
1962-1966	7	5	2	6
1967-1971	6	4	1	9

substantial losses (greater than 20 percent based on beginning price) in the 1967-1971 period than in the earlier period. Consequently, while the performance of the market as indicated by the percentage change in the S&P 500 remained relatively constant, dropping slightly from an increase of 17.75 percent in 1962-1966 to 17.43 percent in the 1967-1971 period, the performance of the constant-ratio plans and the equally weighted buy-and-hold plan was inferior to the S&P 500 in the latter period because of the relatively poorer recovery of the high-beta portfolio from the bear market of 1969-1970.

The better performance of the unadjusted formula plans compared to the buy-and-hold plan where both strategies used the same securities illustrates the advantages of the formula plan in a period when prices are going through a pronounced bull-bear-bull market cycle of the sort experienced from 1967 to the end of 1971. Thus, the equally weighted buy-and-hold portfolio produced an ending dollar value of $4194 after commissions compared to a value of $4402 for the high- and low-beta constant-ratio plan using the same securities throughout and $4980 for the adjusted beta plan. The quarterly rebalancing called for by the constant-ratio plan was able to take advantage of market price fluctuations whereas the buy-and-hold plan was forced to "live with" the prices established at the beginning of 1967.

1962-1971

For the entire ten-year period the results from using constant-ratio plans are again mixed. The constant-ratio plans all outperformed the S&P 500 but only the beta-adjusted portfolios did better than the equally-weighted buy-and-hold portfolio on a total ending dollar value basis after adjusting for commissions. These results are shown in Table III-8. From the standpoint of geometric mean return the two formula plans using Treasury bills and high-beta stocks performed better than either the equally-weighted buy-and-hold or the S&P 500 while the two formula plans using low- and high-beta stocks performed about the same as the equally-weighted buy-and-hold portfolio and better than the S&P 500. After adjusting for risk, the constant-ratio plans are shown in Table III-8 to have a larger return per unit of market risk assumed than the S&P 500. In addition, the constant-ratio plans using Treasury bills as the low-risk portfolio produced much better returns per unit of market risk than the equally-weighted buy-and-hold portfolio while the low-beta constant-ratio plan produced comparable returns per unit of risk.

Over the ten-year period, which encompassed two strong bull markets and three bear markets, the constant-ratio plans taken as a whole performed only slightly better than the equally-weighted buy-and-hold plan. The average ending dollar value of the four plans was $6796 after commissions compared to $6560 for the equally-weighted buy-and-hold and $6630 for the buy-and-hold portfolio when treasury bills are substituted for the low-beta stock portfolio. The better geometric mean performance of the plans utilizing Treasury bills can be explained by the fact that there was less price variability in these plans. That is, the value of the Treasury bill portfolio was assumed to be unchanged during the three-month intervals between rebalancing and over the entire life of the plan whereas the value of the low-beta stock portfolio was allowed to change according to the monthly prices of its component securities.

TABLE III-8

COMPARATIVE RESULTS - CONSTANT-RATIO PLANS, 1962-1971

Type of Plan	Ending Dollar Value* Before Comm.	After Comm.	Monthly Geo. Mean	Annualized Geo. Mean	Ave. Beta	Treynor Index
Unadjusted Betas W/ Treasury Bills	$6638	$6464	1.0124	15.94%	.931	.0964
Unadjusted Betas W/ Low-Beta Stock	$6461	$6298	1.0081	10.16%	1.255	.0482
Adjusted Betas W/ Treasury Bills	$7494	$7251	1.0111	14.16%	.978	.0807
Adjusted Betas W/ Low-Beta Stock	$7389	$7171	1.0069	8.60%	1.260	.0543
Buy-and-Hold Low-Beta Stock	$3900	$3860	1.0043	5.28%	.647	.0200
Buy-and-Hold High-Beta Stock	$9301	$9261	1.0082	10.30%	1.862	.0511
Buy-and-Hold Equally Weighted High & Low Betas	$6600	$6560	1.0062	7.70%	1.255	.0545
Buy-and-Hold S&P 500 Index	$5743	$5703	1.0057	7.06%	1.000	.0299

*Beginning Value for each plan was $4000.

Another factor contributing to the better geometric mean performance of the treasury bill plan was the loss in market value over the ten-year period in the low-beta portfolio. The rebalancing of the two portfolios every three months so as to have 50 percent of the total value in each of the high- and low-risk portfolios had the effect of increasing the value of the low-risk portfolio over the ten-year period and decreasing the value of the high-risk portfolio as compared with the buy-and-hold portfolios as shown in Table III-9.

TABLE III-9

ENDING VALUE OF UNADJUSTED-BETA PORTFOLIOS, 1962-1971*

	Buy & Hold	Constant-Ratio Plan
Low-Beta Portfolio	$1930	$3148
High-Beta Portfolio	$4630	$3150
Total	$6560	$6298
Treasury Bills	$2000	$3233
High-Beta Portfolio	$4630	$3231
Total	$6630	$6464

*After commissions of one percent on all stock purchases and sales.

Thus the difference in the ending value of the Treasury bill plan compared with the low-beta plan is entirely explained by the loss in the value of the low-beta portfolio. This loss resulted in smaller amounts being rebalanced by the formula plan mechanism over the plan's life and a consequent smaller ending value.

The considerably higher ending dollar value of the adjusted-beta plans can only be explained by the superior price performance of the securities substituted for those whose beta coefficient had changed enough to warrant replacement. In particular the substitution of Lowes Inc. for AMP Inc. and Great Western Financial for Lukens Steel at the beginning of 1970 along with the substitution of Motorola for General Signal at the beginning of 1971 accounts for much of the difference in ending dollar values.

In summary, the performance of the constant-ratio plans over the three periods studied is disappointing in that they did not generally outperform the equally-weighted buy-and-hold policy. Only when substitution was permitted did the performance of the formula plans versus the buy-and-hold plan turn in favor of the formula plan. Even then, the better performance of the beta-adjusted plans may have been a change occurrence which would not be replicated using a different set of substitute securities. It is perhaps some consolation to the formula plan investor that, on a risk-adjusted basis, the constant-ratio plan using Treasury bills with their assumed zero beta performed better than the buy-and-hold plan.

Variable-Ratio Plan Results

1962-1966

Table III-11 shows that all four of the variable-ratio plans tested substantially outperformed the S&P 500, both as to ending dollar value after commissions and as to monthly geometric mean return. Furthermore, all four of the plans produced significantly larger geometric mean returns than the equally weighted buy-and-hold portfolio. The large volume of commissions generated under the two stock portfolio variable-ratio plans did, however, reduce the final value of their portfolios below that of the equally-weighted buy-and-hold portfolio.

Moreover, the generally superior performance of the variable-ratio plans was achieved without the plan being largely invested in high-risk stocks. During this five-year period the proportions invested in the high- and low-beta stock portfolios are shown in Table III-10.

TABLE III-10

PROPORTIONS INVESTED IN HIGH- AND LOW-BETA PORTFOLIOS, 1962-1966

Low-Beta %	High-Beta %	$ of months
90%	10%	12
70%	30%	25
50%	50%	17
30%	70%	4
10%	90%	2
		60

Thus, for 90 percent of the time, the plan was invested 50 percent or less in high-beta stocks and 62 percent of the time the investment in high-beta stocks was 30 percent or less. The weighted average ratio of low- to high-beta stocks during the entire period was 63 percent to 37 percent respectively, or almost two to one.

In light of the relatively low participation by the high-beta securities, the performance of the variable-ratio plans compares even more favorably with either the buy-and-hold plans or the constant-ratio plans and lends support to the idea that formula plans can improve the performance of a portfolio over the course of several market cycles.

Table III-11 also shows that the risk-adjusted performance of the variable-ratio plans was even more favorable than the geometric mean

TABLE III-11

COMPARATIVE RESULTS - VARIABLE-RATIO PLANS, 1962-1966

Type of Plan	Ending Dollar Value* Before Comm.	After Comm.	Monthly Geo. Mean	Annualized Geo. Mean	Ave. Beta	Treynor Index
Unadjusted Betas W/ Treasury Bills	$6142	$5810	1.0124	15.94%	.679	.2927
Unadjusted Betas W/ Low-Beta Stock	$5952	$5328	1.0108	13.76%	1.071	.1269
Adjusted Betas W/ Treasury Bills	$6147	$5810	1.0101	12.82%	.707	.2383
Adjusted Betas W/ Low-Beta Stock	$6013	$5377	1.0101	12.82%	1.059	.1753
Buy-and-Hold Low-Beta Stock	$3848	$3808	1.0037	4.53%	.622	.0347
Buy-and-Hold High-Beta Stock	$7632	$7592	1.0124	15.94%	1.836	.0941
Buy-and-Hold Equally Weighted High & Low Betas	$5740	$5700	1.0080	10.03%	1.229	.0938
Buy-and-Hold S&P 500 Index	$4710	$4670	1.0060	7.44%	1.000	.0331

*Beginning Value for each plan was $4000.

return comparisons would indicate. The better risk-adjusted performance was due in large measure to the lower average beta of the variable-ratio plans compared to the equally-weighted buy-and-hold portfolio. Thus, the average beta of the portfolios using all stock was 1.0712 (unadjusted) and 1.0595 (adjusted) compared to an average beta of 1.229 for the buy-and-hold portfolio. For Treasury bill/high-beta plans the Treynor Index number was more than three times as large as for the equally-weighted buy-and-hold portfolio due to the much lower average betas of .6793 (unadjusted) and .7067 (adjusted). These low average beta coefficients are the result of assuming a zero beta for the Treasury bill portfolio and the previously mentioned fact that the average ratio of Treasury bills to high-beta stocks during the period was 63 percent to 37 percent.

<u>1967-1971</u>

During this essentially bear market period, the variable-ratio plans continued to perform better than either the S&P 500 or the equally-weighted buy-and-hold portfolio, at least in terms of the geometric mean. As shown in Table III-13, the total dollar value of the four formula plans was, with one exception, above that of the equally-weighted buy-and-hold portfolio and, in two out of four cases, below the ending value of the S&P 500. Once again, commissions considerably reduced the total dollar returns on the portfolios using both high- and low-beta stock.

As in the previous period, the price-earnings ratio of the S&P 500 seldom dictated that the variable-ratio plans be heavily invested in high-risk securities as shown in Table III-12.

TABLE III-12

PROPORTIONS INVESTED IN HIGH- AND LOW-BETA PORTFOLIOS, 1967-1971

Low-Beta %	High-Beta %	$ of months
90%	10%	8
70%	30%	16
50%	50%	23
30%	70%	12
10%	90%	1
		60

The weighted average participation in the formula plan by high-beta stocks was 44 percent with the formula plan being invested 70 percent or more in high-beta stocks only 22 percent of the time. Apparently the historical price-earnings ratio record of the S&P 500 prior to 1962 somewhat overstated the average price-earnings ratio of the period covered by this study, thus causing the distribution to be slightly skewed to the left (i.e. in the direction of a higher than average investment in the low-beta portfolio than would have been expected).

As pointed out earlier in this chapter, the 1967-1971 period was unusual in that the S&P 500 Stock Index performed better than either the high-beta buy-and-hold or the equally-weighted buy-and-hold portfolios even though their average beta coefficients were higher than the market index. However, in contrast to the constant-ratio plan results presented earlier, the two adjusted-beta variable-ratio plans did achieve higher ending dollar values after commissions than the S&P 500.

TABLE III-13

COMPARATIVE RESULTS - VARIABLE-RATIO PLANS, 1967-1971

Type of Plan	Ending Dollar Value*		Monthly	Annualized	Ave.	Treynor
	Before Comm.	After Comm.	Geo. Mean	Geo. Mean	Beta	Index
Unadjusted Betas W/ Treasury Bills	$4846	$4578	1.0076	9.51%	.894	.0664
Unadjusted Betas W/ Low-Beta Stock	$4526	$4042	1.0053	6.55%	1.247	.0340
Adjusted Betas W/ Treasury Bills	$5528	$5209	1.0083	10.43%	.948	.1064
Adjusted Betas W/ Low-Beta Stock	$5302	$4706	1.0076	9.51%	1.238	.0478
Buy-and-Hold Low-Beta Stock	$3962	$3922	1.0049	6.04%	.671	.0117
Buy-and-Hold High-Beta Stock	$4506	$4466	1.0039	4.78%	1.889	.0321
Buy-and-Hold Equally Weighted High & Low Betas	$4234	$4194	1.0044	5.41%	1.280	.0150
Buy-and-Hold S&P 500 Index	$4697	$4657	1.0054	6.68%	1.000	.0206

*Beginning Value for each plan was $4000.

<u>1962-1971</u>

For the ten-year period Table III-14 shows that the total dollar performance of the variable-ratio plans was superior to that of the S&P 500 in all four cases and superior to the equally-weighted buy-and-hold in three out of four cases. From the geometric mean standpoint, the variable-ratio plans produced considerably better returns than either the S&P 500 or the equally-weighted buy-and-hold. In fact, the geometric mean performance of the four variable-ratio plans was better than the geometric mean performance of the high-beta buy-and-hold portfolio. On an ending total dollar after commissions basis, the high-beta buy-and-hold portfolio was superior to the variable-ratio plans. Consideration of risk versus return as indicated by the Treynor Index numbers in Table III-14 shows that the variable-ratio plans produced a higher return per unit of market risk assumed than any of the buy-and-hold portfolios. Especially large Treynor Index numbers were produced by the variable-ratio plans using a combination of Treasury bills and high-beta stocks. This was due to the low average beta over the life of the plan in combination with the highest geometric mean returns. The low average beta was, in turn, a function of the formula plan mechanism which called for a certain proportion of high-risk to low-risk securities depending on the price-earnings ratio of the S&P 500. Over the ten-year period the average proportion of high- to low-risk securities was 30.2 percent to 69.8 percent. In only three of 120 months did the formula call for 90 percent investment in the high-risk portfolio. In fact, the formula called for an investment of 50 percent or less in the high-risk portfolio 84 percent of the time. When the relatively low participation by the high-risk stock portfolio is

TABLE III-14

COMPARATIVE RESULTS - VARIABLE-RATIO PLANS, 1962-1971

Type of Plan	Ending Dollar Value* Before Comm.	Ending Dollar Value* After Comm.	Monthly Geo. Mean	Annualized Geo. Mean	Ave. Beta	Treynor Index
Unadjusted Betas W/ Treasury Bills	$8030	$7173	1.0109	13.89%	.758	.1612
Unadjusted Betas W/ Low-Beta Stock	$7306	$5909	1.0076	9.51%	1.159	.0891
Adjusted Betas W/ Treasury Bills	$9319	$8296	1.0092	11.62%	.825	.1669
Adjusted Betas W/ Low-Beta Stock	$8861	$7061	1.0089	11.22%	1.146	.0877
Buy-and-Hold Low-Beta Stock	$3900	$3860	1.0043	5.28%	.674	.0200
Buy-and-Hold High-Beta Stock	$9301	$9261	1.0082	10.30%	1.862	.0511
Buy-and-Hold Equally Weighted High & Low Betas	$6600	$6560	1.0062	7.70%	1.255	.0545
Buy-and-Hold S&P 500 Index	$5743	$5703	1.0057	7.06%	1.000	.0299

*Beginning Value for each plan was $4000.

considered, the performance of the variable-ratio plans is all the more impressive.

Within the variable-ratio plans themselves it is apparent from Table III-14 that the unadjusted and adjusted-beta plans using Treasury bills and high-beta stocks generated better results than the high- and low-beta plans even though the average beta levels were lower for the Treasury bill plan. These results can be explained by the fact that over this time period interest rates were generally rising, especially in the latter half of the period. Consequently, the returns produced by the Treasury-bill portion of the plan were better than the returns produced by the low-beta stock portfolio which ended the period with a smaller total value than at the beginning. For example, over the ten-year period the average annual yield on one-month treasury bills rose from 2.64 percent in 1962 to a peak of 6.41 percent in 1969. By contrast, the low- beta buy-and-hold portfolio declined in value from $4000 in 1962 to $3900 by the end of 1971. Out of the twenty securities in this portfolio, four experienced losses of 20 percent or less and six experienced losses of more than 20 percent. These losses more than offset the nine stocks whose prices appreciated less than 50 percent and the one stock whose price appreciated more than 50 percent. The decline in capital value offset somewhat the substantial dividend return of the low-beta portfolio and resulted in an average annual geometric mean return of only 5.28 percent.

The volume of commissions generated by the variable-ratio plans was high, especially in the plans using both high- and low-beta portfolios of stock. In relation to ending value before commissions,

commissions amounted to 11 percent for the two high-beta treasury bill plans compared with 19 percent and 20 percent for the two plans using high- and low-beta stock portfolios. These high levels of commissions raise a question about the usefulness of combining a portfolio of low-beta stocks with a portfolio of high-beta stocks as opposed to the Treasury bill/high-beta stock combination. This question will be examined more fully in the next chapter.

General Observations

Two additional general observations about the results reported in this chapter should be dealt with before moving on to the final conclusions.

First, it is apparent from an examination of Table III-3, p. 44, that the adjusted-beta plans usually produced an increase in ending dollar value after commissions. This outcome was not the result of hindsight being used in the substitution procedure. Rather, it was primarily the result of higher beta coefficient securities being substituted for securities with declining beta coefficients during a period of generally rising prices. It will be observed in Table III-4 that the variable-ratio plans using treasury bills always outperformed the variable-ratio plans using a low-beta stock portfolio. Table III-3 shows that adjusted-beta plans almost always outperformed the unadjusted-beta plans. Hence, from these two tables it can be inferred that it was the performance of the high-beta substitutes which resulted in the adjusted-beta plans outperforming the unadjusted plans. The substitution of Loews for AMP Inc. in 1968 accounts for a large part of the difference in ending dollar values between the unadjusted and adjusted-beta variable-ratio plans in both the 1967-1971 period and the 1962-1971 period. During the 1968-1970 period Loews was one of the more notable conglomerates of American industry and the price of this "fad" stock rose very rapidly from 124 1/2 in December 1967 to 320 5/8 in December 1971 after adjusting for three stock splits during this period.

It will also be observed that a comparison of the rankings of the formula plans using ending dollar value after commissions is somewhat different from the same comparison using the annualized geometric mean. For example, an examination of Table III-14 reporting the results of the variable-ratio plans and buy-and-hold plans over the 1962-1971 period shows that the plan with the highest ending dollar value after commissions was the buy-and-hold high-beta portfolio with a value of $9261. However, the unadjusted-beta plan using Treasury bills reported the highest annual geometric mean. A complete ranking is shown in Table III-15.

One major factor accounting for these differences in rank is the inclusion of dividends as well as market price changes in the calculation of the geometric mean. Secondly, the ending dollar value figure is based on values of the portfolio securities at a single point in time whereas the geometric mean is an average over a period of time. The geometric mean calculation is downward biased. That is, a highly variable series over some time period will produce a lower geometric mean than a less variable series, even though both series produce the same ending value. Thus, the fact that the high-beta buy-and-hold portfolio had the highest ending dollar value but only the fourth best geometric mean can be partially explained by the greater volatility of

TABLE III-15

COMPARATIVE RANKINGS BETWEEN ENDING DOLLAR VALUE AND ANNUALIZED GEOMETRIC MEAN FOR VARIABLE-RATIO PLANS, 1962-1971

Plan	Rank			
	Ending Dollar Value		Annualized	
	Before Comm.	After Comm.	Geometric Mean	Ave. Beta
Unadjusted Betas W/ Treasury Bills	4	3	1	7
Unadjusted Betas W/ Low-Beta Stock	5	6	5	3
Adjusted Betas W/ Treasury Bills	1	2	2	6
Adjusted Betas W/ Low-Beta Stock	3	4	3	4
Buy-and-Hold Low-Beta Stock	8	8	8	8
Buy-and-Hold High-Beta Stock	2	1	4	1
Buy-and-Hold Equally-Weighted	6	5	6	2
Buy-and-Hold S&P 500 Index	7	7	7	5

this portfolio compared with the unadjusted-beta plan using Treasury bills which produced the highest geometric mean but only the third best ending dollar value. The effect of volatility on geometric mean is shown in Table III-15 by observing the strongly inverse relationship between the average beta level rank of each portfolio and the geometric mean rank. A final factor that partly contributed to the difference in rankings was the fact that the geometric mean was calculated before commissions whereas ending dollar values were calculated allowing for a one percent commission on all sales and purchases.

The commission factor caused some distortion between the adjusted and unadjusted beta portfolios due to the much larger volume of commissions generated by the adjusted beta portfolios, especially for the variable-ratio plans.

CHAPTER IV

RESERVATIONS, IMPLICATIONS AND CONCLUSIONS

This thesis has presented the results from simulating the performance of two types of formula-timing plans and has compared these results with the results obtained from simulating buying and holding three different stock portfolios. The unique aspect of this study was the integration of some of the implications about the risk-return relationship of common stocks which have developed in the literature of portfolio theory with the use of formula plans as a timing device for making investment decisions. Specifically, the study uses portfolios of high-beta stocks and low-beta stocks in combination with timing rules from two standard types of formula plans, the constant-ratio and the variable-ratio, to see if superior results could be obtained when compared with buy-and-hold plans.

The results generally support the idea that the use of these types of formula-timing plans did produce superior investment results over those obtained from a simple buy-and-hold strategy. A number of implications relating to the usefulness of the capital asset pricing model can be drawn from these results. First, however, several reservations about the generality of this study should be observed.

Reservations

One major reservation concerns the manner in which the high- and low-beta sample portfolios were chosen. A completely random sampling from the highest and lowest beta classes of New York Stock Exchange securities was ruled out in order to avoid the possibility of substantial changes over the time period studied in the beta level of individual portfolio securities. Examination of the Sharpe-Cooper risk-class data showed that many securities which were classified in the highest risk class as of January 1, 1962 would probably not continue to be classed as high-risk securities in the future owing to their past record of instability. In order to avoid the complications stemming from constant revision of portfolio securities during the time period studied, a screening technique was used which resulted in the high- and low-beta portfolio securities being randomly chosen only from a subset of the total population of high- and low-beta securities. This subset consisted only of those securities which had shown considerable previous risk-class stability. As a result of this selection process the generality of the results is reduced. In defense of this selection procedure, however, it can be argued that an investor interested in a formula-timing approach to investment management would want to avoid the larger transactions costs that would be generated by random selection. Instead, it is likely that he would use some type of screening procedure to create a portfolio whose individual security betas would remain relatively stable over time.

A second reservation concerns the assumption of continued cyclical patterns in stock prices. For the formula plans examined in this study to perform well in the future depends largely on continued cyclical stock markets. There is no reason to believe that the stock market will not continue a rather pronounced cyclical pattern similar to the 1962-1971 period. In addition it is necessary, at least for the variable-ratio plan, to assume that the market does not drastically alter its perception of the appropriate range of price-earnings multiples at which stock should sell over the course of a market cycle. Any major change would make the variable-ratio plan useless as a timing device, at least until the transition period in price-earnings levels had passed.

Events in the marketplace since the end of this study confirm this caveat. During 1972 the market as represented by the S&P 500 Index continued to rise from year-end 1971 levels, reaching a daily high of 121.74 on January 11, 1973, an increase of about 20% over the year. During this same period the price-earnings ratio of the S&P 500 fluctuated from a low of 17.80 in July, 1972 to a high of 22.11 in April 1972. Yields on short-term government securities fluctuated between 5.5 percent and 6.0 percent. Thus the variable ratio plans would have been invested either 70 percent or 90 percent in the low-beta portfolio or Treasury bills. Performance would likely have been worse than the S&P 500.

Beginning in January, 1973, the market began an erratic decline which carried the S&P 500 Index down to a level of 95.95 on December 31, 1973, a decline of some 24 percent for the year. The price-earnings ratio however, was declining even more rapidly as earnings rose to new highs while prices declined. By the end of 1973 the price-earnings ratio of the S&P 500 had declined to about 12.5 from 19.5 at the beginning of the year. Variable-ratio plans would have been in a position of constantly selling low-beta securities or treasury bills and purchasing additional amounts of high-beta securities. By year-end the portfolio would have been 90 percent invested in high-beta securities and would have remained so invested during the first nine months of 1974. Clearly, the performance of variable-ratio plans would have been poor during all of 1973 and into 1974 as high-beta stocks were purchased in a declining market. Furthermore, the low-beta stocks purchased in 1971-72 and sold in 1973 would probably have been sold at substantial losses, especially the utility stocks which were in their own unique bear market during most of this period.

Certainly the action of the market since 1971 reinforces the notion that the market will continue to revolve between bull and bear markets. The question is whether investor worries about inflation, high interest rates, huge capital expenditure requirements for additional production capacity and pollution control equipment, etc. have created a new environment in which prices will reflect a permanently lower level of valuation in relation to earnings. If so, the variable-ratio formula plan investor will be forced to abandon the price-earnings ratio ranges established in this study and set up a new range which reflects the permanently lower price-earnings levels. On the other hand, the experience of 1973-74 may be an aberration from normal market performance which will end when the high rates of inflation and interest rates moderate. In this case the variable-ratio plan investor should see the losses suffered in 1972-74 offset when the market recovers to normal price to earnings valuation levels and his high-beta portfolio responds appropriately.

The results reported in this study and their implications as an investment strategy in the future must be qualified to the extent that the market does not reward the acceptance of high risk with proportionately high returns. Such a situation is not expected; indeed it is economically irrational to expect investors to continue to put their money at risk without appropriately higher returns.

A third reservation centers on the advisability of substituting new securities into the existing portfolio in an attempt to keep the portfolio beta from rising (falling) too much. The results of this study imply that such switching is really not necessary and only increases the level of transaction costs. The problem is that replacement of only a few of the stocks in a twenty-stock portfolio does not have much impact on the overall portfolio beta. Furthermore, when both high- and low-beta portfolios are employed, the reduction in the overall beta of the low-risk portfolio offsets the increase in the overall beta of the high-risk portfolio, leaving the combined portfolio beta almost unchanged. For example, over the 1962-1966 period the average beta of the low-risk portfolio was .622 without replacement and .560 with replacement. The high-beta portfolio had an average beta of 1.836 without replacement and 1.910 with replacement. When the two portfolios are combined in equal amounts, as in the constant-ratio plan, the average beta of the combined portfolios is only changed from 1.229 without replacement to 1.235 with replacement. Thus, unless a large proportion of the beta coefficients for individual securities prove unstable and hence require massive replacement in the portfolio, it does not appear that replacement will significantly affect results. Indeed, should massive replacement prove necessary at frequent intervals the whole idea of using high- and low-beta securities in a formula-timing plan would be called into question. There will undoubtedly be changes in the product mix, management, capital structures and other fundamental factors related to the operation of the firms represented in the portfolio. Such changes will cause some of them to move out of their original risk-class, thus necessitating replacement. Still, the results of this study suggest that yearly examination and replacement represents a minimum period between replacement decisions.

A fourth reservation about the generality of the results in this study concerns the poor performance of the low-beta portfolio. As detailed in Chapter III, the low-beta portfolio declined in value during all three of the periods studied. This poor performance could be attributed to the fact that the portfolio was heavily weighted with gas and electric utility stocks, a class of security whose price appreciation was severely curtailed by rising interest rates and inflation. Thus it is possible that a portfolio of low-beta stocks with utilities excluded would have produced better results both in the buy-and-hold portfolios and in the formula plans. To test this proposition, the twelve non-utility stocks in the portfolio were separated out and buy-and-hold results calculated, assuming equal dollar investment in each of the twelve stocks by pro-rating the results so that they were comparable with the results of the twenty-stock low-beta portfolio used in this study. As shown in Table IV-1 there would have been some improvement in the final value of the low beta portfolio before transaction costs had the utility stocks been excluded.

Instead of a 2.5 percent loss in market value over the 1962-1971 period the low-beta buy-and-hold portfolio would have produced a gain of 8.8 percent. Of course the formula plan results would also have

TABLE IV-1

COMPARISON OF LOW-BETA PORTFOLIO VALUE
WITH AND WITHOUT UTILITY STOCKS

Period	Buy-and-Hold Value with Utilities*	Buy-and-Hold Value ex-Utilities
1962-1966	$3848	$3971
1967-1971	$3962	$4524
1962-1971	$3900	$4351

*Before commissions and based on an initial investment of $4000.

been better had the utility stocks been excluded from the low-beta sample. Indeed, since the variable-ratio plan was often heavily invested in low-beta stocks as explained in Chapter III, the ending results would have been even more favorable to the formula plans vis-a-vis the buy-and-hold plans. Thus, from the standpoint of practical implementation of the formula-plan investment strategy it would appear desirable to exclude utility-type securities from the list of low-beta stocks, at least as long as high interest rates, inflation and regulatory lag make these securities unattractive on fundamental investment grounds.

A fifth reservation concerns the impact of transaction costs on final total dollar results of the formula plans. As pointed out in Chapter III, transaction costs were quite large for the variable-ratio plans using high- and low-beta securities. In efficient capital markets it is claimed that no trading strategy can consistently outperform a buy-and-hold strategy of similar risk after allowing for transaction costs. The results of this study do not confirm this proposition, although it might be argued that the one percent commission rate used understates the amount of transaction costs that would actually be incurred. Certainly it is true that transaction costs greatly reduced the performance of the variable-ratio plans using portfolios of high- and low-beta stock. Furthermore, some of these transaction costs were unnecessary in the sense that there was some whipsawing in the variable-ratio plans as the price-earnings ratio of the S&P 500 moved above and below the price-earnings level at which portfolio rebalancing was called for. Thus, over the entire ten-year period there were six instances of the price-earnings ratio calling for rebalancing at a new ratio of high- to low-risk securities only to reverse itself the following month. One possible solution to the problem of whipsawing might be to use a delaying rule. Such a rule prevents the formula plan investor from taking action to adjust his portfolios until some period of time has passed since the last adjustment occurred. A delaying rule is inherent in the type of constant-ratio plan used in this study. However, it would be possible to use, for example, a one-month delaying rule for the variable-ratio plan. Under this rule no action to rebalance the two portfolios to new proportions would be taken until the movement of the price-earnings ratio from one range into another was confirmed the following month. This type of rule would be particularly valuable in a bear market as it would delay the sale of low-beta stocks or Treasury bills an additional month and allow high-beta stocks to be purchased at even lower prices. That is, assuming that the low-risk portfolio declines much less than the high-risk portfolio, a delaying rule of one month would serve a twofold purpose; that of eliminating whipsawing and the consequent greater transaction costs and would also allow the investor to maximize his purchases of high-risk securities at lower prices as compared with a non-delaying rule formula plan.

A final reservation about the generality of the results of this study relate to the efficiency of the portfolios developed by combining high- and low-beta securities or high-beta securities and Treasury bills. An efficiently diversified portfolio in portfolio theory requires that the returns form the portfolios be highly correlated with returns on the market. A high correlation coefficient implies that much of the unsystematic risk in the individual security returns has been diversified away and that future returns on the portfolio, given an estimate of the market return, are highly predictable. The literature contains numerous studies of the efficiency of diversification for various kinds of portfolios. Wagner and Lau (46), for example, measured the increase in correlation with the market as the size of their portfolios increased from one to twenty securities. The portfolios were randomly selected from six groups of securities, each group consisting of securities rated A+, A-, B+, B, B-, or C by Standard & Poor's. They found that for portfolios of twenty securities, the correlation coefficient varied from about .95 to about .89 for the six quality classes. The lowest quality classes corresponded to the highest beta classes and vice-versa.

The efficiency of the portfolios used in this study was sampled by regressing the monthly return from the two unadjusted constant-ratio plans and the two unadjusted variable-ratio plans for the 1962-1971 period against the monthly returns on the S&P 500 Index for the same period and then calculating the correlation coefficient for each formula plan-market pairing. The correlation coefficients for the constant-ratio plan and the variable-ratio plan using Treasury bills as the low-risk portfolio were .703 and .717 respectively. These results are not as good as those obtained in other studies and indicate that the combination of twenty high-beta stocks and Treasury bills does not completely eliminate the variance in portfolio returns due to unsystematic risk. However, this finding of less than optimum diversification might have been expected. The use of Treasury bills as the low-risk portfolio obviously introduces a variability which is much more highly correlated with money market conditions and prevailing monetary policy than with the stock market. Furthermore, the high-beta portfolio, consisting as it does of securities at the extremes of the risk distribution of all securities contains considerable unsystematic risk. This is seen from the correlation coefficients between individual securities and the market which, for the high-beta portfolio, generally ranged from 30 to 40 percent. It may well be that high-bet securities as a group contain so much unsystematic risk that simply combining some number of them will never produce the kind of diversification found when the same number of less volatile securities are combined. Wagner and Lau reached similar conclusions in their research (46, Exhibit 2, p. 50).

As expected, the efficiency of the formula plan portfolios improved somewhat when low-beta stocks were used as the low-risk portfolio. Correlation coefficients increased to .774 and .779 for the constant-ratio and variable-ratio plans respectively. These results are still not as good as those obtained by Wagner & Lau but are comparable to the correlation coefficients found by other investigators for such specialized mutual fund portfolios as the Value Line Special Situations Fund, Fidelity Trend Fund, Chemical Fund or the Keystone B series of bond funds. The combining of high- and low-beta portfolios is, in fact, much like a specialized mutual fund in that it seeks to obtain performance different from the market as a whole. Thus, the formula plan investor attempting to make use of the volatility characteristic of different classes of securities will apparently have to accept some reduction in the efficiency of his portfolios and consequently less predictability than investors who choose to follow the more conventional approach of buying and holding a randomly selected portfolio.

Implications

A number of implications for the practical application of portfolio theory to the management of portfolios can be drawn from the results of this study.

One assumption of portfolio theory is supported, namely that the beta coefficient for individual securities and, more importantly, for portfolios of securities is quite stable over time; at least stable enough to use in a formula-timing plan context. Out of the original twenty securities in the low-beta portfolio, only three (American Can, Outlet Co. and Standard Oil of California) had large enough changes in their beta coefficients to require replacement for the remainder of the ten-year period. Two others (Safeway Stores and First National Stores) temporarily moved out of their risk-class and required replacement for periods of two years and one year respectively before they once again moved back into their low-risk category (see Appendix A for a description of the replacement process.)

The high-beta portfolio proved even more stable than the low-beta portfolio. Only one stock (AMP Inc.) required replacement for a period longer than one year. Four others (Lukens Steel, General Signal, Evans Products and Lear Siegler) required replacement for one year each, with three of these replacements occurring at the end of the ten-year period.

Thus the portfolio theory assumption of stable beta coefficients held up quite well for the individual stocks in this study although the stability was probably influenced by the selection process used. In addition it is possible that the beta stability found in this study was influenced by the choice of securities from only the two highest and two lowest risk-classes. Casual examination of the Sharpe-Cooper risk-classes shows a greater stability for the securities in the highest and lowest risk-classes than for intermediate risk-class securities. Thus it is possible that, in addition to the selection process used in this study, there is an additional element of stability added to the portfolio securities by virtue of their having been selected from the extremes of the distribution. It can be speculated that high- and low-risk companies represent companies whose business operations are based on fundamental economic characteristics which consistently produce either highly volatile or highly stable stock price patterns. Certainly the utility and consumer goods companies which make up most of the low-beta sample have historically produced very stable earnings patterns. Similarly, demand-supply conditions for the products produced by many of the high-beta securities (electronics, airlines, specialty metals) can change very quickly and in large enough magnitude to produce highly volatile earnings patterns. Whatever the underlying reasons, it appears that selecting relatively stable high- and low-risk portfolios is a task that any investor can perform without serious difficulty.

The five-year (60-month) beta coefficient was used in this study primarily because of its wide use in the literature as a more or less representative period over which to calculate beta. It is possible, however, that this interval is too long for the purpose of recognizing that a security has shifted out of its relative risk-class. Ideally, the measurement interval for beta would be long enough to avoid eliminating a security because of a temporary shift in its beta coefficient. The interval must be short enough so that there is not a long lag in recognizing that a security has permanently moved from one risk-class to another. Although the five-year beta appeared to work relatively well in this study, a shorter interval of perhaps three years might be more appropriate. For example, a stock with a beta of 1.80 over a three-year period which in the succeeding year drops to 1.0 would produce a beta of 1.53 (1.80 x 2/3 + 1.0 x 1/3) for the most recent three-year period whereas a five-year beta of 1.80 would drop to only 1.64 (1.80 x 4/5 + 1.0 x 1/5). The drop from 1.80 to 1.53 would probably be great enough to at least cause the formula-plan investor to re-examine the security and decide whether or not to retain it in the high-risk portfolio, whereas the drop to 1.64 might not be a large enough change to signal such a re-examination. In either case, it should be noted that the impact of a major decrease in the beta coefficient of one security on the twenty-security portfolio return would not be significant. Only when a large number of securities in the portfolio simultaneously move out of their risk-class would there be a major change in expected portfolio return. Such a massive shift did not occur during this study and, given the stability of beta argument, would not be likely to occur in the future.

Another aspect of this study which has implications for the practical application of portfolio theory lies in the area of transaction costs and the relative merits of using Treasury bills or a low-beta stock portfolio in a formula plan. The results indicate that the use of a risk-free asset such as Treasury bills and a high-risk stock portfolio produce superior performance when compared to plans using high- and low-risk stock portfolios. This conclusion has support in the literature of portfolio theory. Recent empirical testing of the capital asset pricing model, notably the studies of Black, Jensen and Scholes (2), Friend and Blume (20), and Fama and MacBeth (16), has shown that ex-post return is not strictly proportional to the measure of systematic risk (i.e. the beta coefficient). That is, stocks with above average risk demonstrated higher returns than stocks with below average risk, but there was little evidence to indicate that assuming higher amounts of risk within the high-risk group resulted in additional increments in return. While the risk-return relationships were found to be approximately linear over long periods of time, the tradeoff of risk for return is, in actuality, less than that predicted by the capital asset pricing model (i.e. the ex-post risk-return relationship had a smaller slope than predicted). Black, Jensen and Scholes suggest that ex-post return can be better explained by substituting a "zero-beta" portfolio for the risk-free rate used in the capital asset pricing model. In theory this zero-beta portfolio would consist of common stocks which have zero correlation with the market and which would yield a return higher than the risk-free rate. Unfortunately, the composition of the zero-beta portfolio is not explained but its use is claimed to produce a better "fit" to the risk-return line of average relationship than is obtained when the risk-free rate is used.

On the other hand, if one continues to assume a risk-free rate at which investors can both lend and borrow then one implication of these empirical findings is that superior returns for any level of risk could have been obtained by borrowing at the risk-free rate and investing in low-risk stocks. The leverage provided by the borrowed funds can be adjusted to the desired risk level of the investor. Although this study did not directly confirm these findings indirect support can be found by comparing the results of the formula plans using a low-risk portfolio of stock with the results obtained from using Treasury bills as the low-risk portfolio. The formula plans using Treasury bills, especially the variable-ratio plans, are clearly superior to those using a low-beta portfolio of stock. Part of this superiority is accounted for by the higher transaction costs incurred with the low-beta portfolio. However, even on a before transaction costs basis the pairing of comparable high-beta/Treasury bill plans and high/low-beta plans shows that the high-beta/Treasury bill plan produced higher geometric means in eleven out of twelve pairings and higher ending dollar values in all twelve pairings (see Table III-4, p. 45). Deletion of the utility stocks from the low-beta portfolio might alter this conclusion. As indicated in Table IV-1, the buy-and-hold value of the low-beta portfolio without utilities included appreciated 8.8 percent over the 1962-1971 period and undoubtedly would have resulted in higher geometric mean returns for the formula plans using a low-beta portfolio of stock. Whether the returns would have been better than produced by using Treasury bills is doubtful, however, since the Treasury bill portfolio does not pose the risk of capital losses that use of any type of stock portfolio presents (i.e., monthly returns are never negative when Treasury bills are used). Also, transaction costs would have been higher with any low-risk stock portfolio than with Treasury bills.

An examination of Tables III-1a, 1b, and 1c (pp. 40, 41, 42) seems to imply an inverse relationship between the annualized monthly geometric mean and the average portfolio beta. However, it should be pointed out that this inverse relationship is the result of assuming that the average beta for the variable-ratio formula plans can be calculated by weighting the average beta of the high- and low-beta portfolios by their proportionate representation in each month of the period covered. Also it should be re-emphasized that the treasury bill portfolio was assumed to have a zero beta. As reported in Chapter III, formula plan rules called for a high percentage of the total portfolio value to be invested in the low-risk portfolio during much of the 1962-1971 period. Thus it is not surprising that there was an inverse relationship between the geometric mean return and the average beta of the formula plans since the variable-ratio plans using treasury bills produced the highest geometric mean returns. The results of this study tend to confirm the capital asset pricing theory idea that using an extreme beta portfolio and leveraging with a risk-free asset can produce superior investment results.

Conclusions

Modern portfolio theory as conceived by Markowitz and subsequently refined and developed by Sharpe, Lintner, Treynor and others provides a powerful methodology for structuring portfolios of securities and measuring their performance in terms of both risk and return. This study has sought to adapt some of the principles of portfolio theory to not only the structuring of portfolios but also to the question of the timing of portfolio purchases and sales over the course of several market cycles.

Specifically, the idea that portfolio risk is related to the volatility of the component securities of the portfolio was used to structure portfolios of high- and low-risk securities. Trading in these portfolios was then simulated using the portfolio adjustment rules contained in constant-ratio and variable-ratio formula timing plans.

In an efficient market, new information about securities is assumed to be fully and immediately reflected in their price. Since new information enters the market randomly, price changes over time will be random and independent of each other. Furthermore, it is presumed that, in the absence of inside information, no trading strategy will produce higher returns than the returns obtained from buying and holding a well diversified portfolio of equal riskiness. The results of this study are, in some measure, a refutation of the efficient market hypothesis since the use of formula-timing plans was found to produce superior returns when compared to the kind of buy-and-hold strategy recommended by portfolio theory.

To some extent this seeming refutation of the efficient market hypothesis can be rationalized by the differences in risk between the formula plans and the buy-and-hold strategy. Especially in the case of the variable-ratio plans, the level of risk in the portfolio does not remain constant. The switching back and forth between the high- and low-risk portfolios according to the formula plan rules results in a varying level of risk and should produce a return different from simply buying and holding the same securities. The shifting of funds between the two portfolios is based on fundamental, not market, grounds. That is, the higher the price-earnings ratio of the S&P 500 Index the riskier the market is presumed to be on the assumption that the more dollars in price an investor pays for a dollar's worth of earnings, the more risky the investment in the sense that the probability of high returns from that investment is diminished. On the other hand, the constant-ratio plan does keep risk exposure constant by periodic rebalancing between the high- and low-risk portfolios. However, the very act of rebalancing the portfolios means that the returns to be expected from a constant ratio plan should be different than the return from a buy-and-hold portfolio where no rebalancing occurs. Previous studies by Evans (13) and Cheng and Deets (7) have demonstrated that a strategy of periodic rebalancing produces superior results relative to buy-and-hold. Thus, imperfect as the formula plans are as timing devices, this study shows that an improvement over buy-and-hold results could have been achieved using the simple formula plan rules.

Additional research is needed to confirm the results of this study. Specifically, testing of formula plans over other time periods and using different samples of high- and low-risk securities are needed in order to provide the generality necessary to convince portfolio managers of the usefulness of the formula plan approach. Additional types of formula plans might also be experimented with to see if better results than those obtained in this study can be achieved. The use of a delaying rule in the variable-ratio plan has already been mentioned as one possible change. In addition using a variable-ratio plan with the proportions of high- and low-risk securities tied to a monetary indicator such as the level of interest rates might be a useful approach since the level of interest rates provides some indication of the competition that the stock market is likely to be facing for the funds of investors.

Another area for additional research that falls within the general framework of this study is in the area of maintaining a given beta level in a portfolio. This study used an adjustment process in which securities were replaced only after the 60-month beta coefficient fell below (or rose above) a predetermined level. As discussed earlier, it is possible that some other measurement period might more quickly signal a significant change in a security's volatility level without, at the same time, causing too many unnecessary replacements. Reduction in this recognition lag might increase the returns from a formula plan type of investment strategy.

Finally, it should be kept in mind that considerable controversy still surrounds the use of the historically-derived beta coefficient as a proxy for the riskiness and expected return on a security. Certainly there are many investors who do not accept the definition of risk as used in portfolio theory. Further testing of other measures of risk as well as additional testing of the capital asset pricing model is necessary to clarify the question of whether or not the beta coefficient is the "best" measure of risk. Especially important is a convincing demonstration that the beta coefficient, over time, provides a good explanation for the way a security is priced in the market

relative to other securities. Only when this question is more convincingly answered will practitioners in the investment community be willing to adopt the type of investment strategy suggested in this study.

APPENDIX

APPENDIX

SELECTION AND REPLACEMENT PROCEDURE

As explained in Chapter II, the securities used in this study consisted of twenty-five high-beta and twenty-five low-beta securities selected from the two highest and two lowest deciles of the Sharpe-Cooper risk-class study (41). Selection from these securities was random with securities to be used in the study chosen after examination of each randomly selected security for prior price stability. The first twenty securities selected in each group were used as the beginning portfolios with the remaining five used as substitutes. The beta coefficient for each security was initially calculated for the sixty-month period beginning January 1, 1962. Then at the end of each successive year the beta coefficients were again calculated by adding the price data for the most recent year and dropping the initial year's prices. Thus, beta coefficients were calculated for 1962-1966, 1963-1967, 1964-1968, 1965-1969 and 1966-1970.

The substitution procedure consisted of setting a lower limit of 1.50 for high-beta stocks and an upper limit of .75 for low-beta stocks. As soon as a security's five-year beta coefficient fell below or rose above these levels the security was replaced with one of the remaining substitute securities. The initial twenty securities included in each portfolio and the ten replacement securities are shown in Table A-1. Table A-2 indicates the specific securities which replaced and the time and duration of their replacement.

TABLE A-1

BETA COEFFICIENTS OF LOW-BETA STOCK PORTFOLIO

Beginning Low-Beta Portfolio	Sixty-Month Beta Coefficient					
	1962-66	1963-67	1964-68	1965-69	1966-70	1967-71
Alabama Gas	.38	.11	.14	.11	.30	.32
Amalgamated Sugar	.55	.79	.62	.78	.97	.43
American Can	.81	1.06	1.07	1.42	1.06	.71
American El. Power	.73	.56	.72	.84	1.08	.92
Atlantic City El.	.87	.72	.47	.61	.62	.50
Campbell Red Lake	-.66	-.43	-.68	-.09	.28	-.01
Columbia Gas	.59	.57	.44	.50	.46	.52
Duquesne Light	.66	.65	.50	.54	.60	.47
First National Stores	.56	.77	.71	.76	1.14	1.07
Ligget & Myers	.86	.56	.52	.57	.48	.62
National Biscuit	.71	.68	.74	.70	.74	.43
Niagra Mohawk	.64	.53	.41	.52	.58	.45
Outlet Company	.73	.88	1.42	1.75	1.90	1.48
Pacific Lighting	.47	.36	.50	.43	.63	.70
Puget Sound Power & Light	.60	.67	.61	.69	.80	.71
Safeway Stores	1.07	1.28	.41	.67	.76	.73
Standard Brands	.78	.77	1.04	1.06	1.12	.75
Standard Oil of California	.81	1.05	1.06	1.28	1.08	.84
United Corp.	.74	.70	.77	.80	.74	.54
Wrigley	.54	.17	.29	.36	.45	.73
Low-Beta Substitute Securities						
Missouri Public Service	.88	1.11	1.04	1.07	1.06	.56
Hakensak Water	.62	.67	.60	.60	.71	.37
Shell Transp. & Trd.	.59	.62	.65	.66	.72	.41
Washington Water Power	.41	.19	.14	.36	.45	.42
Gt. Nor. Iron Ore	.50	.45	.32	.40	.19	.08

TABLE A-2

BETA COEFFICIENTS OF HIGH-BETA STOCK PORTFOLIO

Beginning High-Beta Portfolio	Sixty-Month Beta Coefficient					
	1962-66	1963-67	1964-68	1965-69	1966-70	1967-71
Admiral	2.11	2.55	2.78	2.93	2.10	1.75
Allegheny	1.83	2.46	2.51	2.74	2.76	2.42
American Airlines	1.68	2.35	2.09	2.07	1.75	1.92
AMP	1.73	1.33	1.69	1.64	1.25	1.12
Bell & Howell	2.06	2.09	2.26	2.11	1.63	1.63
Cenco Instruments	2.12	2.14	2.08	2.27	2.66	2.39
Eastern Airlines	2.09	2.64	2.56	2.71	2.04	2.26
Evans Products	1.68	2.18	2.68	2.57	2.07	1.46
Fansteel	1.52	1.77	2.03	2.31	2.16	1.93
Flour	1.89	1.70	2.29	2.49	1.80	1.73
Foxboro	1.79	1.89	1.84	1.66	1.86	2.11
General Signal	1.63	1.91	1.90	2.12	1.63	1.35
Hoffman Electronics	2.09	1.99	1.97	2.42	1.96	2.08
Lear Spiegler	1.15	1.85	2.43	2.63	2.32	1.95
Leesona	2.24	2.70	2.99	2.93	2.76	2.15
Lukens Steel	1.89	1.72	1.62	1.50	1.44	1.47
Standard Kollsman	1.96	2.71	2.82	2.76	2.24	2.14
U.S. Industries	1.82	1.99	2.47	2.39	2.20	1.82
Western Union	1.55	1.82	2.01	2.08	1.72	1.34
White Consolidated	1.90	2.05	2.58	3.05	2.37	2.77
High-Beta Substitute Securities						
Loews	1.76	2.39	3.41	3.88	3.45	2.55
Litton	1.61	1.59	2.21	2.70	2.44	2.06
Motorola	1.32	1.61	1.86	1.80	1.77	1.78
General Refractories	1.94	1.47	1.73	1.89	2.01	1.65
Great Western Financial	1.90	2.58	1.86	2.05	1.79	1.91

TABLE A-3

TIMING OF SECURITY REPLACEMENTS

Low-Beta Portfolio

1. American Can replaced for 1967-1971 with Hakensak Water.

2. Outlet Co. replaced from 1968-1971 with Shell Transport & Trading.

3. Standard Oil of California replaced from 1968-1971 with Washington Water Power.

4. Safeway Stores replaced in 1967 and 1968 with Great Northern Iron Ore.

5. First National Stores replaced in 1971 with Great Northern Iron Ore.

High-Beta Portfolio

1. AMP replaced for 1968-1971 with Loews.

2. General Signal replaced in 1971 with Motorola.

3. Lukens Steel replaced in 1971 with Great Western Financial.

4. Lear Siegler replaced for 1962 only with General Refractories.

5. Bell & Howell replaced in 1971 with Litton Industries.

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