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INVESTMENT PERFORMANCE EVALUATION:
A STUDY OF MUTUAL FUNDS IN IMPERFECT SECURITIES MARKETS

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A Thesis

in

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of

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Abstract

Rationale is offered to explain the immense popularity of mutual funds in light of the research findings which suggest that mutual funds are unable to do significantly better than a large unmanaged portfolio. The role of commission costs is examined with respect to the alternative choices of investing in mutual fund shares and investing in a small number of common stocks Using historical monthly returns, for the period January 1988 to December 1992, random sample portfolios consisting of between two and twenty-five common stocks are constructed based on Random Diversification, the Single Index Model, and Markowitz formulation techniques. Portfolios and mutual funds are ranked both before and after commission costs, using Sharpe's ratio, and performance is compared. The results are consistent with the hypothesis that owing to market imperfections, such as indivisibility of securities and transactions costs, the purchase of mutual fund shares is a rational investment decision, but only when the alternative is an investment in a small number of common stocks.

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CHAPTER I

INTRODUCTION

The evaluation of mutual fund performance has generated a considerable amount of interest in virtually all circles of life. business circles, academic circles, family circles, etc. An extensive amount of research has been performed in an attempt to evaluate empirically the performance of mutual funds Evaluation techniques have been suggested, criticized, reformulated, and implemented, but the general results provide support to the contention that mutual funds, as investment vehicles, are unable to outperform the market[1]. Consequently, the average investor would be equally well off were they to invest in a randomly chosen portfolio of common stocks[2]. However, mutual funds, as evidenced by their explosive growth rates, have gained such immense popularity that they are now the second largest group of financial intermediaries in the United States with $2.1 trillion in assets Moreover, it is the fastest growing group. In 1993, mutual fund assets increased 26.1 percent, more than twice the rate of 10.8 percent experienced by the life insurance industry, which is the second fastest growing financial intermediary[3].

The mutual fund industry plays an important role in financial markets by uniting investors with security issuers As such, mutual funds contribute not only to general economic growth through their effect on capital markets and on capital formation but also to shareholder well-being The economic role is principally the result of the popularity of mutual funds as alternative investment products for investors The predominance of such instruments has led mutual funds to become major players in the credit and capital markets This exceptional growth of mutual funds is especially difficult to account for in light of the empirical evidence on

their overall performance Total sales of long-term funds hit a record high of US$ 511 6 billion in 1993, with equity mutual funds sales reaching $228.2 billion representing an extraordinary 43 3 percent increase in assets. This rate of growth appears to be paradoxical in respect of the empirical findings that "there is very little evidence that any individual fund was able to do significantly better than that which we expected from mere random chance"[4]

Recent attempts to evaluate empirically the performance of mutual funds have lead researchers to contend that mutual funds, collectively, are unable to outperform the market Consequently, investors would fare equally well by investing in randomly chosen portfolios of common stocks. Despite these negative evaluations the popularity of mutual funds continues to grow. The justification behind this phenomenon can be ascertained by analyzing the benefits accruing to investors in mutual funds in the context of imperfect securities markets Mutual funds typically comprise varying objectives and consequently policies However, there are two common objectives sought by virtually all mutual funds. In the first instance, funds seek to increase returns through active management of the assets within a portfolio and exploitation of economies of scale. Second, funds seek to reduce the level of investment risk through efficient diversification of the portfolio. These two common goals provide the individual investor with quantifiable measures of relative success. Thus, for the average individual investor the decision between investing in mutual funds or directly in a portfolio of common stocks would require an analysis and comparison of the degree to which the fund has succeeded in achieving these collective objectives with the expenses incurred in providing the management services

Two major studies, Sharpe (1956) and Jensen (1968), are responsible for the commonly held view that mutual funds typically exhibit results which are not superior to that of an unmanaged portfolio. This evidence has led researchers, such as Friend and Vickers (1965),

to conclude that investors would be equally well off if they simply invested their savings in a randomly chosen sample of common stocks However, the normative inferences drawn from such evidence regarding the desirability of investing in mutual fund shares raises two important issues which remain unresolved what rationale can be suggested to explain not only the popularity of mutual funds as investment alternatives but also their explosive growth rates. Second, what role do commission costs play with respect to attainable investment choices.

The research goal of this thesis is to suggest plausible answers to these issues by analyzing the risk-adjusted returns accruing to investors in equity mutual fund shares and comparing these to (1) the risk-adjusted returns from a direct investment in common stock portfolios created using optimal and random portfolio selection techniques consisting of between 2 and 25 randomly selected stocks and (2) the risk-adjusted net returns to determine whether commissions costs and portfolio stock levels (i e.diversification levels) are influential with respect to these two alternative investment choices

This study contributes to the literature by (1) expanding on the scope of previous mutual fund perfomance research by implemeting a methodology proposed by Levy and Sarnat (1984). Essentially, Levy and Sarnat assert that a representative basis of comparison is one which recognizes that, owing to market imperfections, such as indivisibility of securities and transaction costs, an investment in a proxy for the market portfolio is simply unattainable by the average investor Indeed, even a modest size index, consisting of say 100 securities, is prohibitively expensive and not within the financial means of the average investor. Consequently, the average investors is confronted with the following two alternatives: invest in the shares of mutual funds or invest directly in a small number of common stocks. The explicit

recognition of these two investment alternatives as essentially viable options for investors is instrumental in explaning investor behaviour

CHAPTER II

LITERATURE REVIEW

This chapter analyzes the current state of the literature and theory as it relates to the research objectives outlined in the preceeding chapter.

The initial section of this chapter focuses on performance evaluation and its general importance The second section reviews the evaluation measures and their impact on the evaluation of performance Finally, the last section addresses the selection of a market proxy and the associated impact on performance measures and portfolio selection models.

Performance Evaluation

The investment performance of professional mutual fund managers has been the subject of extensive research in the financial literature Studies have been designed to elicit important empirical information to both financial practitioners and theorists In the case of practitioners, one goal of measuring performance is to enable an objective assessment of both the skills and abilities of professional fund managers For theorists, "the importance of performance measures resides not only in their application for analyzing investment management and the efficiency of capital markets but their relevance and potential utility for cost of capital problems"[5]. However, the usefulness of these measures is entirely dependent upon the validity of the assumptions underlying their foundation, which involves the pricing of risky assets under uncertainty

Evaluation has primarily relied on one-parameter measures of performance which combine both rate of return and risk dimensions into a single measure which adjusts for

differences in risk. A single risk-adjusted measure is not only simpler than a combination of risk and return measures, but it permits, at least theoretically, a definitive comparison of performance for investments with dissimilar levels of return and risk.

Three traditional measures of performance - (1) Sharpe's ratio, (2) Treynor's ratio, and (3) Jensen's performance index - were developed primarily as an outcome of Harry Markowitz's pioneering work in portfolio theory Emerging from a comprehensive re-evaluation of the pricing of assets under uncertainty was a theory of equilibrium in the capital markets. The Sharpe-Lintner security pricing model or Capital Asset Pricing Model (hereinafter CAPM) as it is now referred to, led to these three different, although related, one-parameter measures of the investment performance of assets and portfolios

If the CAPM holds while the market is in equilibrium and is expected to remain permanently in equilibrium, no investor can achieve an abnormal return in the securities market, in excess of the mean return expected by the CAPM risk-return relationship Each stock and each portfolio yields an identical rate of return adjusted for risk. Under such circumstances, there is very little remaining for the investment analyst to do; they do not possess any special knowledge which may help earn an abnormal return However, if the stock market was seldom in equilibrium and once it attained equilibrium it deviated therefrom almost instantaneously, some securities or portfolios could yield abnormal returns Consequently, it is appropriate to employ evaluation techniques which measure the performance of a particular stock or portfolio relative to the equilibrium risk-return relationship

Alternative Performance Measures

In general, measures of investment performance have given explicit recognition to the bivariate nature of the risk averse investor's objective - return maximization and risk minimization. These single, risk-adjusted, measures of performance are not only elementary in their nature when compared to a combination of risk and return measures, but they provide a means of definitively comparing, on a theoretical basis, the performance of investments with dissimilar rates of return and levels of risk. Three widely used performance indicators based on capital market equilibrium theory include: **(a)** Sharpe's (1966) Reward-to-Variability Ratio, **(b)** Treynor's (1965) Reward-to-Volatility Ratio, **(c)** and Jensen's (1968) Performance Index. Each of these conventional measures of performance are discussed below.

Sharpe's Reward-to-Variability Ratio

William Sharpe (1964) developed, based on a relationship first described by Tobin (1958), the reward-to-variability ratio, where variability is measured by the standard deviation of return, which expresses the investors reward per unit of variability, to evaluate the investment performance of mutual funds Sharpe reasoned that the expected return on a portfolio composed of common stock securities was related to the pure or risk-free rate of interest plus a premium demanded by investors as compensation for bearing the inherent risk of equity securties This relationship was expressed as follows:

$$R_i = R_f + b\sigma_i \qquad (2.1)$$

where R_i is the expected rate of return on a portfolio of stocks, R_f is the interest rate on government bonds, b is the risk-premium, and σ_i is the standard deviation of the expected returns, a measure of total risk. The risk-premium required to induce investors to assume risk

can also be viewed as a coefficient of risk aversion, which becomes evident if the equation is rewritten in the following form:

$$b = \frac{R_i - R_f}{\sigma_i} \qquad (2.2)$$

This is the reward-to-variability ratio since it measures the investor's expected incremental return for bearing risk. Consequently, it can be used as a measure for assesing performance.

Treynor's Reward-to-Volatility Ratio

Jack L. Treynor (1965) developed an index of portfolio performance that is based on systematic risk, as measured by the portfolios' beta coefficient To analyze performance, the characteristic regression lines of each portfolio under analysis must be calculated by estimating equation (2.1) which is, $R_i = A_i + ß_i R_m + U_i$. Treynor's ratio is defined by equation (2.3) which expresses the investors reward per unit of systematic risk.

$$T = \frac{R_p - R_f}{\beta_i} \qquad (2.3)$$

where R_p = average rate of return on portfolio p

β_p = beta coefficient for portfolio p

R_f = risk-free rate

In theory, if all risky securities and portfolios have constant reward-to-volatility ratios, equal to $\frac{\bar{R}_m - R_f}{\beta_m}$, then the risk-adjusted mean rate of return on each portfolio is as predicted by the CAPM.

Jensen's Performance Index

Jensen (1968) modified the characteristic regression line rendering it practical as a one-parameter investment performance measure. He demonstrated that by running a time-series regression of the *i*th security's excess rate of return $(R_i - R_f)$ on the market portfolio's excess rate of return $(R_m - R_f)$ using the following equation (2.4) $R_i - R_f = A_i + (R_m - R_f)/\beta_i + U_i$ the vertical incercept, A_i, was useful as a measure of performance Essentially, Jensen restates the original characteristic line of Treynor into risk-premiums instead of returns The intercept of the regression line, or Jensen's "alpha", is an estimate of the excess returns from a particular asset. If the asset is correctly priced so that it yields returns which are neither higher nor lower than the appropriate risk-premium, then Jensen's alpha would have a zero value. Hence, Jensen's "alpha" is a measure of disequilibrium in the market As such, this measure can be used to evaluate the investment performance of assets in relation to the market

Suitability of Performance Measures

Difficulties may be perceived in the direct application of these three measures of investment performance since they were developed in terms of *ex ante* values. Jensen, however, demonstrated that it is possible to obtain unbiased estimates of his alpha in risk-premium form providing the level of systematic risk and the risk free rate of interest are constant over time. Since the expected returns on any security are strictly unobservable, Jensen's regression line must be restated in terms of the objectively measurable ex post returns. Despite these difficulties, the practicality of all three one-parameter measures of performance is

largely dependent upon the validity of the assumptions underlying the capital asset pricing model

Friend and Blume (1970) conducted an analysis of the adequacy of these one-parameter measures of performance by measuring the relationship between these measures and the risk from which they are presumed to abstract To test their theory of independence between the measures of performance and the corresponding measures of risk Friend and Blume regressed Sharpe's, Treynor's, and Jensen's measures against both the beta coefficients and the standard deviation of portfolio returns. Their results indicated that in all cases, risk-adjusted performance is dependent upon risk measures. The relationship was inverse and highly significant. They concluded that the Sharpe, Treynor, and Jensen measures of portfolio performance yielded seriously biased estimates of performance, with the magnitudes of the bias correlated to the level of portfolio risk Consequently, Friend and Blume questioned the numerous studies of mutual fund performance based on these measures (e g Sharpe (1966), Jensen (1968), and Lintner (1965b) particularly in those instances where attempts were made to evaluate individual portfolios or when the average risk of these portfolios differed from that of the market index Furthermore, Friend and Blume considered it preferable to use the rate of return and variability of returns to measure performance in lieu of the one-parameter measures, since the former did not require specifying an explicit functional relationship between risk and return

Market Proxy and Index Selection

Research in the area of performance evaluation has, for the most part, concentrated on the ability of the mutual fund to generate returns which are superior to that of a proxy market

portfolio or a naive buy-and-hold strategy. These evaluation techniques have primarily used popular indices as proxies for the market portfolio and as an appropriate benchmark for comparison The use of such indices for evaluation purposes is suitable under the assumption of perfect capital markets. However, the appropriateness of these benchmarks becomes questionable in the case of imperfect securities markets.

The impact of the indices chosen for evaluation purposes in the case of the Single Index Model and Multiple Index Models is controversial. particularly so when the security universe is expanded to include heterogeneous assets The definition of market equilibrium requires excess demand to equal zero for all securties. This implies that all securities offered in the market must be held by some investors. Since a basic premise of capital market theory is that all investors unanmously desire to hold the market portfilio (MK), it follows that; in equilibrium, MK must be the portfolio containing all marketable assets in the proportion x_i where

$$X_i = \frac{Total\ value\ of\ the\ i^{th}\ security}{Total\ value\ of\ all\ assets\ in\ the\ market}$$

In theory, the market portfolio contains all marketable securities; common stock, preferred stock, bonds, real estate, commodities, options, art objects, cash, etc. in the exact proportion in which they are supplied in equilibrium Index models measure the expected return E(R) and variance of securities by relating the return of a given security to the performance of the market as represented by an index of market activity.

The importance of the index selected to represent market or class returns is demonstrated by Roll (1978). Roll states that the selected index may be equally weighted, market value weighted, or Markowitz efficient. Further, the index can be based on a small

sample of securities or upon all of the securities For every index there is a beta for every asset (and all portfolios), but these betas can and will, in most cases, be different depending on the selected index. This is futher exacerbated by the fact that the magnitude of the beta for a particular asset will be larger or smaller depending on the index Consequently, the choice of an index, or benchmark, plays a major role in the evaluation and interpretation of absolute and relative performance.

In the context of well diversified portfolios, of which mutual funds can be an example, the relevant risk measure is frequently expressed as the beta coefficient of the characteristic line of the portfolio under consideration The estimation of beta is achieved by regressing the returns of the portfolio on the mean-variance efficient market portfolio Numerous researchers, including Grinblatt and Titman (1989b), Jensen (1968), and Sharpe (1966), have employed indices such as the Dow Jones Industrial Average and the Standard and Poor's 500 Stock Index to approximate the market portfolio, and hence capital asset pricing model (CAPM) benchmarks. Roll (1978) has been critical of this approach contending it to be inconsistent in logic primarily since the equilibrium model assumes homogeneous investor expectations and information As such, the measurement of superior performance could only occur if the market portfolio proxies were mean-variance inefficient. There is sufficient evidence, including anomalies involving dividend yield, firm capitalization, and price/earnings ratios, to support this contention of inefficiency. Indeed, researchers, such as Grinblatt and Titman (1989), have made specific reference to the benchmark selection problem and ways to mitigate the possibility of driving the results of their research. Consequently, a review of the appropriateness of these benchmarks and their impact on portfolio selection is warranted

Some research has suggested that alternative risk-adjusted procedures should not demonstrate substantive differences in performance measures Stambaugh (1982), for example, found that the choice of a market proxy made little difference in capital asset pricing model tests Similarly, Roll (1978) found that three market proxies provided nearly identical performances measures for randomly selected portfolios and that these risk-adjusted methods produced almost the same rankings as no adjustment at all Copeland and Mayers (1982), in a study analyzing Value Line rankings, also concluded that the choice of a performance benchmark did not affect inferences relating to the ranking of performance

However, Lehman and Modest (1987) investigated the sensitivity of mutual fund performance measures to CAPM and arbitrage pricing theory (APT) benchmarks and concluded that the establishment of what constitutes normal performance is exceedingly important for evaluating managed portfolios Lehman and Modest maintain that if the choice of a benchmark was unimportant the use of different benchmarks would yield similar results. This contention is not supported by their empirical evidence. Grinblatt and Titman (1988) conducted a study designed to analyze the appropriateness of several benchmarks in performance evaluation and to determine the sensitivity of Jensen's measure to them. An eight-portfolio benchmark was developed to account for irregularities relating to firm size, dividend yields, and mean reversion in equity returns. Grinblatt and Titman deemed this portfolio benchmark to be most appropriate since the intercepts of 109 passive portfolios constructed on the basis of securities' characteristics and industry groupings were closest to zero when this benchmark was employed They concluded that sensitivity relating to the selected benchmark was relevant In a further study by Grinblatt and Titman (1989) research was conducted to test for the existence of abnormal mutual fund performance by examining Jensen's measure The

average performance of both actual and hypothetical mutual fund returns were compared and found to differ substantially across the different benchmarks. Hendricks, Patel, and Zeckhauser (1993) performed a study in which they tested for statistical evidence of short-run persistence in exclusively equity mutual fund performance. The authors reported that the choice among their all equity portfolio benchmarks, which included Grinblatt's and Titman's eight-portfolio benchmark, systematically affected the evaluation of mutual fund portfolios The results indicated a discrepancy as large as 30% in the estimation of beta depending on the selected benchmark. Jensen's alpha was also affected by as much as 40 to 60 basis points depending on the benchmark.

The results of this research suggest the importance of identifying the relevant model for risk and expected return in the context of performance measurement However, the issue is exacerbated due to difficulties in ascertaining whether differences in performance measures are due to measurement errors and/or errors implied by alternative theoretical models Thus, in the case where CAPM benchmarks are employed, interpreting differences in results can only be attributed to measurement error in any proxies due to the unobservability of the true market portfolio.

Recognizing the attendant problems associated with the utilization of benchmarks, some authors have suggested performance measurement without benchmarks Broadly, this type of approach is known as Event Study Measures (ESM) The ESM measure calculates the difference between the returns of the assets in the event period of interest with their returns during a comparison period. It provides an estimate of the sum of the time-series covariances between portfolio weights and the subsequent returns of each asset included in the portfolio under evaluation. Cornell (1979) suggested a performance measure which is an adaptation of

the event study methodology This was subsequently refined and applied by Copeland and Mayers (1982) In a study involving portfolio holdings to evaluate performance, Grinblatt and Titman (1989b) introduced a new measure of performance which utilized an alternative methodology of calculating this time-series covariance The authors concluded that although their technique was more costly to implement, in terms of data collection and computing time, combining traditional evaluation approaches with their proposed technique resulted in a performance measure which is considerably less sensitive than traditional measures.

Portfolio Selection Models

Almost four decades ago, in his classic monograph on portfolio management, Harry Markowitz (1959) popularized one of the few unassailable principles of investment analysis, an investment decision must include both the return anticipated and the level of risk to be undertaken Since return-maximization and risk-minimization are conflicting goals, he developed an approach which incorporated both aspects in the analysis and selection of possible investments The Markowitz model assumes security returns are normally distributed (i e return distributions can be fully explained using two parameters - expected return, E(R), and variance, σ^2, and investors are utility maximizers (more E(R) is preferred to less, while lower σ^2 is preferred) Under these conditions, holding portfolios which maximizes E(R) for a given level of risk or minimize variance for a given level of E(R) maximizes utility. Markowitz demonstrated that portfolio variance is a weighted average of the covariances between the returns on the individual securities under consideration. Through use of estimates for the expected return (n inputs; n equals the number of securities in the investment universe) and variance (n) of each security, as well as the $(n^2 - n)/2$ pairwise covariances between securities,

efficient portfolios can be derived either with calculus, or by using popular quadratic programming techniques

The Markowitz approach provides an analytical framework to selecting securities for investment portfolios This approach, however, falls short of providing a satisfactory solution to the problems confronting portfolio managers in the real world. The reason for this stems from the model's recognition of the pairwise covariances among securities which imposes estimation as well as computational demands which increase exponentially as the number of securities under consideration approaches a level which is adequate for diversification[6] For example, an analysis in which 100 securities are under consideration requires 5,151 data inputs a risk free rate, 100 expected returns, 100 variances, and 4, 950 covariances

The practical application of the efficient portfolio selection problem has been greatly simplified by the set of assumptions contained in the Single Index model (SIM), first suggested by Markowitz as a method of preparing input for his efficient portfolio selection model and later developed by Sharpe (1963) in a manner which capitalized on the computational structure of the data. The distinguishing characteristic of this model is the assumption that various securities are related but only through a common relationship with an index of general market performance. The return from any security is determined by a linear relationship with this market index and by random factors:

$$R_i = A_i + \beta_i R_m + U_i \qquad (2\ 1)$$

where A_i and β_i are parameters which can be estimated for each security using ordinary least squares regression, R_i is the return on security i, R_m is the return of the chosen index, such as the Standard & Poor's Common Stock Index, or other index deemed appropriate within the

context of the desired analysis, U_i is a random variable or residual error term for the ith security

Sharpe's model generates a particular variance-covariance matrix (diagonal matrix) which contains non-zero elements only along the n + 1 diagonal positions This property reduces significantly the computational time and cost (to approximately 1 percent of the cost required under the full Markowitz model) required to generate the efficient set. To derive efficient portfolios, the variance-covariance matrix is repeatedly inverted. Since the SIM produces a diagonal matrix, it is easier to invert than the full matrix produced by the Markowitz approach.

The single index model is considered to perform a second important function in portfolio theory Equation (1) indicates that variation in R_i is introduced from two sources: variation in the index R_m and variation in u_i. Formally stated,

$$\text{Var}(r_i) = \text{Var}(\alpha_i + \beta_i R_m + u_i) \qquad (2.2)$$

$$= \text{Var}(\beta_i R_m) + \text{Var}(u_i) \qquad (2.3)$$

or:

Total Risk = Systematic Risk + Unsystematic Risk

The unsystematic (firm or security related) portion of risk can be virtually eliminated, but the systematic (market) portion is essentially nondiversifiable[7]. The risk attributable to a security in an efficiently diversified portfolio is, therefore, equal to its systematic risk, which is measured by β_i or the beta coefficent[8]. This coefficient is, in the context of the Capital Asset Pricing Model, a measure of security risk.

Prior to the introduction of the single index model, portfolio optimization problems were almost exclusively of academic interest. However, Sharpe's model is considered

instrumental in bridging academic theory with the needs of practioners in portfolio management by reducing not only the cost but also the time required to review and update portfolio contents. Notwithstanding the model's simplifications with respect to inputs and computational requirements, certain important interrelationship among securities (expressed within the context of the Markowitz formulation as independently derived pairwise covariances) may not be fully reflected when the source of variation in individual security returns is deemed to be exclusively related to a single index or economic activity Thus, the assumption regarding the return generating process for the single index model may be an oversimplification which could result in the formualtion of sub-optimal portfolios

Sharpe's introduction of the Single Index Model resulted in an important step toward a computationally simpler model requiring significantly fewer data inputs The distinguishing charateristic of the single index model is the assumption that security returns are related only through a common relationship with an overall index of performance or economic activity The return from any security is determined by this index

Diversification and Commission Costs

Although considerable research has been conducted to analyse and evaluate the issues of professional management and the relative extent of diversification, the costs associated with attaining an adequate level of diversity for the average investor, and their importance in the context of investment choices, has received minimal attention

In a study by Smith and Schreiner (1970), a model was developed to compare the costs of direct diversification by an investor with the costs of indirect diversification through mutual funds. Through standardization of the portfolios under consideration the authors concluded

that a cost comparison for different horizons and investment sizes favoured indirect investment for smaller investors (portfolio holdings < $ 1,000) and direct investment, such as in common stock portfolios, for larger investors (portfolio holdings > $10,000). In a study involving common-stock portfolio performance, Schlarbaum, Lewellen, and Lease (1978) investigated the rates of return earned by a large and diverse sample of individual investors who maintained common stock portfolios over the seven year period 1964-70. Their evidence indicated that, on average, investors earned returns commensurate with the level of systematic risk they assumed and that individuals earned returns which were not statistically different from both the returns available by employing a naive-buy-and-hold strategy and those available from a sample of mutual funds

Summary

The literature review has revealed opposing views and results with respect to the performance of mutual funds. First, there is a common belief that mutual fund investment performance supports the efficient market theory. The view essentially implies that expenditures on research and trading are unnecessary, even wasted, since security prices reflect all available information This is primarily attributable to two studies, Sharpe's (1966) and Jensen's (1968), which demonstrated that mutual funds underperformed common market indices However, there are more recent studies which contradict this efficient market view. The results are inconsistent with the hypothesis that mutual fund expenses and professional management fees are wasted These empirical findings generally support the contention that mutual funds are sufficiently successful in discovering and exploiting new information which more than compensates for the cost involved. Consequently, a modified version of the efficient

market hypothesis which recognizes that not all information is free has been proposed This has given rise to a new area of research which focuses on the determinants of high quality product delivery in a market which is considered to be susceptible to poor quality problems

Turning to the issue of performance evaluation, the techniques which are frequently used, particulary in the case of Sharpe and Jensen, are based on CAPM theory. These measures are, however, dependant on the validity of the underlying assumptions of market theory. There are also difficulties in the application of these performance measures since they were developed in terms of ex ante values but empirical applications and conclusions are primarily based on ex post values Finally, there may be sampling errors or a misinterpretation of risk to the individual investor, in the case of mutual funds, since the risk of poor fund management is excluded. In the case of Sharpe's reward-to-variability ratio, it is assumed that the investor holds only a single asset, such as the shares of only one mutual fund As such, this measure is appropriate for measuring the performance of mutual funds, when it is reasonable to assume that investors only buy the mutual fund's shares and leave the diversification task to the fund manager.

The issue of mutual fund performance has led investigators to question whether conventional measures are sensitive to the benchmark selected to measure performance Roll (1979), for example, found identical performance measures for randomly selected portfolios using three market proxies Similar results were obtained by Copeland and Mayers (1982) and Chen, Copeland, and Mayers (1983). However, Lehmann and Modest (1987) found measures to be very sensitive to the asset pricing model chosen. Grinblatt and Titman (1993) examined performance evaluation without benchmarks Consequently, there is disagreement on the

importance of selecting an index to represent the market portfolio and whether or not benchmarks are required to evaluate performance

In view of the evidence reported, and despite the attendant problems and disagreements regarding performance evaluation in general, can rationale be offered to explain the widespread adoption of mutual funds as an investment vehicle? The resolution of this dilemma is possible by carefully examining the attainable alternatives confronting the average individual investor and comparing these with the benchmark portfolio assumed in empirical studies of mutual fund performance, i.e. investment in the market portfolio. Unless an individual has considerable resources at their disposal, it is not feasible to invest in the 500 shares which comprise the Standard & Poor's 500 Common Stock Index. However, it is viable for an individual to invest in the shares of a mutual fund which may comprise 500 or more different shares The argument that a random sample of stocks may suffice to emulate the risk-return characteristics of an index is valid. However, even this strategy would require 10 to 15 stocks The difficulty surrounding this approach becomes clear when consideration is given to the average cost of one share in the market today A portfolio consisting of one share of Matshusita Electric and one share of Wells Fargo requires a cash outflow of several hundred dollars. Therefore, the number of individual investors for whom even a two or three share portfolio represents the maximum realizable alternative to investing in mutual funds is considerable A more intuitively appealing approach recognizes that market imperfections and indivisibility of securities constrains the alternatives confronting individual investors. This research project addresses these constraints Specifically, the research approach gives explicit recognition to the importance of a relevant benchmark in suggesting rationale for the explosive growth rate and widespread adoption of mutual funds in the United States. This is achieved

through the realisation that, when markets are assumed to be less than perfect, the relevant alternative to an indirect investment in mutual funds is to invest directly in a small portfolio of common stocks. The salient point here is that the market portfolio, or various proxies thereof, are inappropriate benchmarks for comparison. Therefore, mutual fund performance must be compared to the performance of portfolios comprised of a relatively small number of common stocks. These alternative investment possibilities, realizable to average investors given their financial disposition and portfolio management skills, are more representative than the frequently employed alternative of a 300 or 500 stock index.

CHAPTER III

METHODOLOGY

Two research questions were identified in the preceding chapters. The first is the rationale for the widespread adoption of mutual funds as investment media. The second relates to the role of transaction costs on decisions regarding attainable investments in imperfect security markets. This chapter examines the manner in which the research questions will be addressed. To achieve this goal, a security universe containing 932 common stocks and 94 equity mutual funds has been assembled.

This chapter is divided into two topic areas. The first section provides specific details pertaining to the securities in the investment universe, the selection models and the calculation of the input statistics, and the performance measure used in ranking. The second section outlines the research issues and tests used

Data

The security universe is representative of the common stock investment opportunities available over the five year holding period 01/01/88 - 1/12/92 from the New York Stock Exchange. A sample of 932 continuously listed securities with no missing observations throughout the period covered by this study was obtained for use in the construction of both random and optimal portfolios. The monthly rates of return provided for in the CRSP tapes are calculated as follows:

$$R_{(t)} = \frac{P_{(t)} + d_{(t)}}{P_{(t')}} - 1 \qquad (3.1)$$

Where $R_{(t)}$ is the return in time period t, $P_{(t)}$ is the share price at time t, $d_{(t)}$ is the dividend distribution, if any, at time t, and $P_{(t-1)}$ is the share price for the most recent previous period - usually time period t-1.

The mutual fund data consists of monthly returns on 94 U.S. equity mutual funds for the period 1988 - 1992. Data on U.S. funds was obtained from Morningstar Inc The 94 fund sample was selected from the sample of mutual funds used in the study by Hendricks, Patel, and Zeckhauser (1993) and contained in the universe of funds available from the Dow Jones Industrial Retrieval System. To establish the equity content of the chosen funds the Mutual Fund Profiles guide, published by Standard & Poor's Corp., was consulted with respect to portfolio composition at June 30, 1993. In order to be included in the study, the equity content of the fund must have been at least 85% based on asset value The monthly fund returns are based on dividend payments, capital gains distributions, and changes in net asset value; this is therefore a measure of net performance.

The ex-post performance of the efficient equity and randomly selected portfolios will be compared to that of the sample of 94 U.S. equity mutual funds The benchmark equity portfolios are generated using the following three techniques: **(a)** Random Diversification, **(b)** Markowitz (1952) portfolio optimization, and **(c)** Sharpe's Single Index Model The characteristics of these models and their portfolio analysis implications will now be discussed

Random Diversification

Random or simple diversification is a technique which is used to reduce the risk of a portfolio. The method involves the random selection of securities and allocation in equal weight to construct a portfolio. Several studies have shown that the total risk of most

securities, as measured by their variance in rates of return over time, can be apportioned into two components systematic and unsystematic risk. Althcugh the proportions vary among different securities, random diversification will usually decrease the unsystematic portion of total risk toward zero when portfolios are composed of between fifteen and thirty securities[9]. Adding further securities to the portfolio is not expected to reduce its unsystematic risk.

Markowitz Mcdel

Markowitz diversification is a portfolio construction technique in which securities that are less than perfectly positively correlated are combined to reduce portfolio risk without simultaneously reducing portfolio returns. Risk can therefore be reduced below the systematic level Hence, Markowitz diversification can reduce risk to a level which is lower than the level attainable through simple diversification. For a given portfolio, the lower the correlation between securities the lower the level of risk. This process is therefore more analytical than simple diversification due to the explicit consideration the method imparts to the covariances between securities.

The Markowitz model requires the following inputs for each component of the security universe under consideration.

(1) $E(R_i)$ = Expected return on asset i (i = 1,...N).

(2) σ_i^2 = The variance of return for asset i (i = 1,...N).

(3) σ_{ij} = The covariance of returns between assets i and j ($i \neq j$),

(i = 1,...N and j = 1,...N).

(4) R_f = The riskless rate of interest for the investment period.

Hence, the investor is required to estimate the expected return vector **E** and the covariance matrix Σ_n.

The expected return and variance of any portfolio can be expressed as a function of the basic input [$E(R_i)$ and σ_{ij} values] and the proportion invested in various securities:

$$E = \sum_i X_i \bar{E}(R_i) = X'E \qquad (3.2)$$

$$V = \sum_{i=1}^{n}\sum_{j=1}^{n} X_i X_j \sigma_{ij} = X'\sum X \qquad (3.3)$$

The computer program developed to generate n-asset mean-variance efficient portfolios uses an algorithm which is based on the efficient frontier mathematics in matrix form presented in Roll (1977). Furthermore, to estimate the percentage investment in each security under consideration, the proceeds from short-sales plus 100% margin were deemed to have been deposited in an interest bearing account resulting in the following investment proportions stardardization equation.

$$Z_i^* = \frac{X_i}{\sum_{i=1}^{n} |X_i|}, \quad so\ that \sum_{i=1}^{n} |Z_i^*| = 1 \qquad (3.4)$$

Single Index Model

The SIM assumes that the return on any security is uniquely a function of its relationship with the market index and random factors. The return from any security is determined by a linear relationship with this market index and by random factors:

$$R_i = A_i + \beta_i R_m + U_i \qquad (3\ 5)$$

where A_i and β_i are parameters for the *i*th security which can be estimated using ordinary least squares regression, R_m is the return of the market index, and U_i is a random error term for security i The basic assumptions of the model are summarized below:

(a) The return generating process is given by equation (3.5).

(b) $E(U_i) = 0$. That is, the error term is, on average, zero. Note that this assumption is not restrictive. However, if the error term were instead, on average, equal to some constant, $EU_i = A_i$, the general model could be rewritten as follows:

$$R_i = (A_i + A_i) + \beta_i R_m + (U_i - A_i) \qquad (3.6)$$

The expected value of $U_i - A_i$ is zero by design.. Hence the error variance is given by

$$E(U_i^2) = E(U_i - EU_i)^2 = S^2_{Ui}.$$

(c) The error term is uncorrelated with the market index, that is,

$$Cov(U_i,R_m) = E[U_i(R_m - ER_m)] = 0.$$

(d) $[Cov(U_i,U_j)=0]$. This is the crucial assumption of the SIM in that the returns on any two securities i and j are related only through the relationship with the market index R_m. That is, the error terms are uncorrelated.

The single index model requires data inputs for: (1) the regression parameters A_i, β_i, and U_i for each of the 932 securities under consideration, and (2) values for R_m (expected value) and σ_m^2 for the market index. In total, the model necessitates 3N + 2 or 2,798 inputs. Under the assumptions of the SIM model, the portfolio analysis problem is reformulated in a manner analogous to the Markowitz formulation. The portfolio return is defined as before, but is restated here for clarity:

$$R_p = \sum_{i=1}^{n} X_i \bar{R}_i \qquad (3.7)$$

Portfolio variance is defined as the weighted sum of the variances and covariances for all assets in the portfolio equation (3.5), or variance can be measured using portfolio returns and equation (3.6).

$$Var(R_p) = E\left(R_p - E(R_p)\right)^2 \qquad (3.8)$$

The implication of assumption (d), that is, that different assets' regression error terms U_i are uncorrelated, is a simplified portfolio risk formula derived from the general portfolio risk formula, equation (5), resulting in the following formula:

$$Var(R_p) = \sum_{i=1}^{n} X_i^2 \, Var(E_i) + \sum_{i=1}^{n}\sum_{j=1}^{n} X_i X_j \, Cov(E_i, E_j) \qquad (3.9)$$

$$= \sum_{i=1}^{n} X_i^2 \, Var(E_i) \qquad (3.10)$$

In this study, values for A_i, β_i, and E_i were estimated by regressing the return on each security for the period t = 1 to 60 against the return on the value weighted New York Stock Exchange Index, which in this case, is the market portfolio proxy.

When short-sales are permitted, the optimum portfolio with n risky assets is derived from a system of n equations in n unknowns. Under the assumptions of the SIM the optimal investment proportions in n risky assets can be expressed by the following equation proposed by Levy and Sarnat (1984):

$$Y_i = \frac{\beta_i}{\sigma_{ei}^2}\left[(R/V)_i - C^*\right] \quad (i = 1,2,\ldots,n) \qquad (3.11)$$

where $(R/V)_i = (\mu - R_f)/\beta_i$ is the ith security's reward-to-volatility ratio and:

$$C^* = \sigma_m^2 \sum_{j=1}^{n} \frac{\mu - R_f}{\sigma_{ej}^2} \beta_j \Bigg/ \left(1 + \sigma_m^2 \sum_{j=1}^{n} \frac{\beta_j}{\sigma_{ej}^2}\right) \qquad (3.12)$$

The standardized optimal proportions Z_i are calculated as:

$$Z_i^* = \frac{Y_i}{\sum_{i=1}^{n} |Y_i|}, \quad so\ that \sum_{i=1}^{n} |Z_i^*| = 1 \qquad (3.13)$$

However, this approach assumes that, in estimating the optimal proportions, the investment universe dose not contain securities whose mean return is less than the risk-free rate used to calculate the reward-to-volatility ratio. This constraint in no way invalidates the procedure. The rationale behind this relates to the behaviour of risk-averse investors. To attract investment securities must offer returns which are greater than the risk-free rate to compensate them for assuming risk As such, the average risk-averse investor would scrutinize potential investments for securities whose expected mean return was greater than that offered by simply investing in such instruments as Government Treasury bills.

In assessing portfolio performance, it is necessary to consider both risk and return. Sharpe's single parameter portfolio performance index incorporates both aspects of these statistics and permits ordinal ranking. Furthermore, since the investor is assumed to hold shares in only one mutual fund, or a potentially inadequately diversified portfolio, it is the most appropriate measure for this study. For the *i*th portfolio, the index is defined as follows:

$$S_i = \frac{Risk\ Premium}{Total\ Risk} = \frac{\bar{R}_i - R_f}{\sigma_i} \qquad (3.14)$$

Where $\bar{R}_i$ = average return on the *i*th portfolio.

R_f = riskless rate of interest.

σ_i = standard deviation of the returns for portfolio i.

The fact that portfolios may have different average returns or risks will not hinder a direct comparison when employing this index.

Commission Costs

In order to compare, on a net return basis, the ex-post performance of the random and efficient equity portfolios to that of the equity mutual funds it is necessary to estimate the commission costs facing investors at each stock level. Since transactions from brokerage firms predominates that of discount brokers, the cost estimates are based on a commission schedule obtained from a large U.S. brokerage firm The total transactions costs of investing in an n stock portfolio TTC_n can be calculated using the following equation:

$$TTC_n = R - R_n = (1+R) - \left[\frac{(1+R-2F_2T)^n(1-F_3)}{(1+F_1)}\right]^{1/n} \qquad (3\ 15)$$

where F_1, F_2, and F_3 are the appropriate brokerage commission rates, which depend on the size of the trades involved in investing, turnover, and liquidation of the portfolio. When the initial investment is made, F_1 represents the appropriate one-way brokerage commission rate for an investment value of V_0. However, F_1 is also a function of the trade size involved. It is assumed that each year the portfolio growth rate is R, trading commissions incurred are at the rate of F_2, and the portfolio turnover rate is T Finally, at the investment horizon, the portfolio is liquidating resulting in a brokerage commission

rate of F_3. Shanker (1989) calculated the percentage commission rate charged by a large national securities firm as a function of the market price per share and the number of shares traded. These rates where then used to derive an average commission rate based on number of shares traded. Since the investment strategy assumed is a buy-and-hold scheme, the portfolio turnover, T, is zero. The results are illustrated below in Table III-1.

Table III-1.0
Total Transaction Costs per Year of
Investing in an n Stock Portfolio

Number of	Initial Investment (Millions) / Market Price per Share								
Shares in Portfolio	$1.0 $10	$3.0 $30	$5.0 $50	$7.0 $70	$9.0 $90	$11.0 $110	$17.0 $170	$25.0 $250	Monthly Average
1	0.0717	0.0247	0.0167	0.0115	0.0090	0.0084	0.0078	0.0078	0.00163
2	0.0766	0.0371	0.0244	0.0168	0.0129	0.0120	0.0112	0.0108	0.00208
3	0.0807	0.0398	0.0258	0.0176	0.0135	0.0126	0.0115	0.0109	0.00219
4	0.0847	0.0424	0.0273	0.0185	0.0140	0.0132	0.0118	0.0110	0.00229
5	0.0868	0.0451	0.0287	0.0193	0.0146	0.0138	0.0120	0.0112	0.00240
6	0.0897	0.0476	0.0300	0.0201	0.0151	0.0142	0.0124	0.0114	0.00247
7	0.0906	0.0501	0.0314	0.0208	0.0156	0.0146	0.0127	0.0115	0.00254
8	0.0915	0.0526	0.0327	0.0216	0.0162	0.0150	0.0131	0.0117	0.00261
9	0.0924	0.0551	0.0341	0.0224	0.0167	0.0155	0.0134	0.0119	0.00268
10	0.0933	0.0576	0.0354	0.0231	0.0172	0.0159	0.0138	0.0120	0.00275
11	0.0940	0.0576	0.0363	0.0240	0.0177	0.0164	0.0140	0.0123	0.00279
12	0.0947	0.0577	0.0371	0.0248	0.0183	0.0168	0.0143	0.0125	0.00283
13	0.0955	0.0577	0.0380	0.0256	0.0188	0.0173	0.0145	0.0127	0.00287
14	0.0962	0.0578	0.0388	0.0264	0.0194	0.0178	0.0148	0.0129	0.00291
15	0.0969	0.0578	0.0396	0.0272	0.0200	0.0182	0.0150	0.0131	0.00295
16	0.0976	0.0579	0.0405	0.0280	0.0205	0.0187	0.0153	0.0133	0.00299
17	0.0984	0.0579	0.0413	0.0288	0.0211	0.0192	0.0156	0.0135	0.00303
18	0.0991	0.0579	0.0422	0.0296	0.0216	0.0197	0.0158	0.0138	0.00307
19	0.0998	0.0580	0.0430	0.0304	0.0222	0.0201	0.0161	0.0140	0.00311
20	0.1005	0.0580	0.0438	0.0312	0.0227	0.0206	0.0163	0.0142	0.00315
21	0.1008	0.0581	0.0439	0.0314	0.0230	0.0209	0.0165	0.0142	0.00316
22	0.1010	0.0581	0.0439	0.0315	0.0232	0.0212	0.0167	0.0142	0.00317
23	0.1013	0.0581	0.0439	0.0317	0.0235	0.0214	0.0168	0.0142	0.00318
24	0.1016	0.0582	0.0439	0.0318	0.0237	0.0217	0.0170	0.0142	0.00320
25	0.1018	0.0582	0.0440	0.0320	0.0240	0.0220	0.0172	0.0143	0.00321

Research Issues

The premise is that the risk-return trade-off provided by the randomly selected, all equity portfolios, particularly when the number of stocks included in the portfolio is low, is such that investors would be better off, on average, investing in mutual funds Two levels of comparison are employed to examine this hypothesis The first level involves comparing the average risk-adjusted returns, before commission costs, available to an investor in common stock portfolios with the average risk-adjusted returns, before commission costs, available from investing in our sample of 94 equity mutual funds To obtain an estimate of the hypothetical mutual fund returns before commissions (fund returns are net of expenses), the average commission cost applied to the returns derived from a direct investment in equity portfolios was used This comparison of performance will be conducted for each of the different methods outlined above to formulate random or optimal portfolios.

The second level of comparison involves essentially the same direct comparison between the mutual funds and random or optimal portfolios except that in this case commission costs have been estimated and applied to each portfolio level to reflect the net returns accruing to investors.

First Level Comparison of Performance Results

The first level comparison involves calculating Sharpe's reward-to-variability ratio for the average, before transactions costs, return accruing to investors for each of the 24 possible stock level combinations (i e. the average return observed for the 100 random two stock portfolios, the average return of the 100 random three stock portfolios, etc)

over the 60 month period from 01/01/88 to 31/12/92. Sharpe's reward-to-variability ratio is computed for each of the mutual funds. If the risk-adjusted returns accruing to investors of randomly selected portfolios is inferior to that available from investing in mutual funds it offers rational for investor behaviour regarding the choice of mutual funds as investment vehicles.

Second Level Comparison of Performance Results

The second level test involves calculating Sharpe's reward-to-variability ratio for the average returns, net of commission costs, accruing to investors for each of the 24 possible stock level combinations over the 60 month period from 01/01/88 to 31/12/92. This same exercise was carried out for each of the mutual funds using returns for the same period If the risk-adjusted returns, adjusted for the commission costs, accruing to investors of randomly selected portfolios is inferior to that which is available from an investment in mutual funds it demonstrates rational for investor behaviour regarding the choice of mutual funds as investment vehicles.

CHAPTER IV

EMPIRICAL RESULTS

Two primary research questions were outlined in the preceding chapter. The first is that given the attainable investment alternatives facing average investors, where an investment in the market portfolio is excluded, investment in mutual funds is the preferred investment vehicle. The second is that when commission costs are introduced into the decision the investment choices facing investors becomes crystalized. Risk-adjusted performance before commission costs are examined first followed by an examination of performance net of commission costs.

Risk-Return Performance - Before Commission Costs

The first test involves calculating Sharpe's ratio for each portfolio consisting of between two and twenty-five stocks, based on returns before commission costs, and computing the average for each stock level. These results are compared to the average ratio calculated for each of the equity mutual funds. The results, which are summarized in Table IV-1.0, provide little, if any, insight into the rational for the widespread adoption of mutual funds Ordinal ranking of the mean results by each optimal portfolio category, of which mutual funds are an example, indicates mean-variance efficient or Markowitz portfolios are dominant overall Mutual funds rank superior to an investment in a unmanaged portfolio represented by the average return available by investing equally in the 932 stock universe, and perform only marginally superior to a random diversification strategy Consequently, these summary results would seem to support the contention that investors would fare equally well by a direct

investment in equity portfolios consisting of between 2 and 25 stocks. In aggregate, the most highly ranked investment strategy, based on Sharpe's ratio, appears to be a direct investment in a mean-variance efficient portfolio of equity securities constructed using Markowitz's selection model.

Performance Comparison

Mean Gross Returns

Table IV-1.0

Portfolio	Mean Gross Return %	Standard Deviation %	Sharpe's Index	Rank
Mean-Variance Efficient	3.093	5.314	0.487	1
Single Index Model	1.460	2.879	0.332	2
Mutual Funds	1.505	4.172	0.240	3
Random Equally Weighted	1.695	5.013	0.238	4
932 Common Stock Average	1 619	8.722	0.128	

In order to gain insight into this performance, each model's average results, at various stock levels, are compared to the average performance of our 94 mutual funds.

Table IV-1.1 illustrates the results which could have been obtained by investors, before commissions, using a naive, random selection strategy to construct their portfolios. The ordinal ranking is as expected. The average results improve, in an almost linear fashion, as the number of stocks included increases. Relatively speaking, portfolios with higher number of stocks rank better than portfolios with lower number of stocks. On an individual portfolio basis, the mutual funds represent a better investment, based on Sharpe's ratio, up to about the 12 stock level of diversification. Below this level, the average portfolio ratio is less than the

0.240 ratio observed for mutual funds. However, the mean ratio achieved for all portfolios consisting of 12 stocks or more is greater attaining a maximum of 0.274 for a 25 stock portfolio. The evidence suggests that for investors who focus on a small number of shares as potential investment alternatives, (i.e. a level below that which is necessary to reduce unsystematic risk to a minimum) mutual funds represent a superior investment strategy, based on terminal wealth.

Performance of Equally Weighted Equity Portfolios, 1988 - 1992

Mean Gross Return

Table IV-1.1

No. of stock per portfolio	Mean Gross Monthly Return %	Standard Deviation %	Sharpe's	
			Index	Rank
25	1.704	4.385	0.274	1
24	1.700	4.413	0.271	2
23	1.713	4.480	0.270	3
21	1.686	4.407	0.268	4
20	1.684	4.493	0.263	5
19	1.689	4.517	0.262	6
22	1.687	4.516	0.262	7
15	1.710	4.648	0.260	8
17	1.709	4.659	0.259	9
16	1.683	4.585	0.257	10
13	1.699	4.673	0.256	11
14	1.694	4.687	0.254	12
11	1.713	4.783	0.253	13
18	1.682	4.685	0.252	14
12	1.730	4.977	0.246	15
8	1.736	5.181	0.238	16
10	1.695	5.151	0.231	17
9	1.661	5.071	0.228	18
6	1.716	5.386	0.225	19
7	1.700	5.459	0.219	20
5	1.678	5.525	0.213	21
3	1.699	6.318	0.189	22
4	1.619	6.099	0.183	23
2	1.688	7.221	0.164	24
Average	1.695	5.013	0.238	

The results which could have been obtained by investors using the single index model to construct optimal portfolios is illustrated in Table IV-1.2. The ordinal ranking is as in the preceding selection method. Ranking improves as the number of stock included in our

portfolios increases. The results suggest that when an investor is prepared to diversify his investment among three secuirites or less the decision that would maximize their terminal wealth is an investment in equity mutual funds. However, if the investor considers more than three equity securities for his portfolio the preferred decision becomes a direct investment in a common stock portfolio

Performance of Single Index Model Equity Portfolios, 1988 - 1992

Mean Gross Return

Table IV-1.2

No. of stock per portfolio	Mean Gross Monthly Return %	Standard Deviation %	Sharpe's Index	Sharpe's Rank
25	1.221	1.624	0.442	1
23	1.240	1.712	0.430	2
21	1.269	1.795	0.426	3
24	1.234	1.722	0.424	4
22	1.258	1.799	0.419	5
19	1.333	1.990	0.417	6
20	1.265	1.907	0.399	7
18	1.294	2.004	0.394	8
17	1.299	2.048	0.388	9
15	1.374	2.248	0.387	10
16	1.340	2.177	0.384	11
14	1.387	2.307	0.383	12
13	1.418	2.430	0.376	13
12	1.498	2.651	0.375	14
10	1.571	2.902	0.368	15
11	1.459	2.688	0.355	16
8	1.624	3.249	0.345	17
9	1.514	3.015	0.335	18
7	1.634	3.656	0.309	19
6	1.676	3.854	0.304	20
5	1.693	4.131	0.288	21
4	1.764	4.855	0.260	22
3	1.868	5.794	0.235	23
2	1.806	6.533	0.199	24
Average	1.460	2.879	0.332	

Table IV-1.3 exhibits the results obtainable by investors using the Markowitz model to select their optimal investment proportions for portfolio construction. The ordinal ranking of the average portfolio performance is similar to the two previous portfolio approaches. In this instance, investors who consider diversification possibilities based on only two stocks for

potential investment would prefer to invest in mutual fund shares However, for each diversification stock level which exceeds two equity securities investors would prefer a direct investment in equity portfolios.

Performance of Mean-Variance Efficient Equity Portfolios, 1988 - 1992

Mean Gross Return

Table IV-1.3

No. of stock per portfolio	Gross Mean Monthly Return %	Standard Deviation %	Sharpe's	
			Index	Rank
25	4.238	4.985	0.749	1
24	4.313	5.422	0.702	2
23	3.860	4.790	0.701	3
22	4.281	5.662	0.667	4
21	3.697	4.835	0.660	5
20	3.563	4.785	0.639	6
19	3.376	4.604	0.624	7
18	3.332	4.797	0.590	8
17	3.063	4.611	0.555	9
15	3.213	4.921	0.550	10
16	3.352	5.193	0.549	11
14	3.211	5.178	0.523	12
13	2.991	5.005	0.497	13
12	2.974	5.030	0.491	14
10	3.313	6.009	0.467	15
11	3.151	5.727	0.456	16
8	2.645	5.1[illegible]	0.417	17
9	2.461	4.891	0.400	18
7	2.491	5.476	0.363	19
6	2.334	5.330	0.343	20
5	2.078	5.031	0.313	21
4	2.127	5.850	0.277	22
3	2.270	7.335	0.241	23
2	1.893	6.862	0.202	24
Average	3.093	5.314	0.487	

Risk-Return Performance - Net of Commission Costs

The second test involves calculating Sharpe's ratio for the average portfolio consisting of between two and twenty-five stocks based on net returns, that is, after commission costs, and comparing these with Sharpe's ratio calculated for each of the equity mutual funds The results for each investment strategy are summarized in Table IV-2.0. When commission costs are considered, the average results indicate that each direct investment strategy examined here,

except the unmanaged portfolio, is ranked superior to that of the strategy of investing in mutual funds The results suggest that, on average, if investors consider the net returns accruing to them, the optimal choice is one of direct investment in equity securities and not an indirect investment in mutual funds.

Performance Comparison

Mean Net Returns

Table IV - 2.0

Portfolio	Net Mean Return %	Standard Deviation %	Sharpe's Index	Rank
Mean-Variance Efficient	2.811	5.314	0.434	1
Single Index Model	1.178	2.879	0.234	2
Random Equally Weighted	1.413	5.013	0.218	3
Mutual Funds	1.223	4.172	0.172	4
932 Common Stock Average	1.337	8.722	0.095	

A comparison of each model's average performance, at various stock levels, to the average and individual performance results of our 94 mutual funds is performed to permit further analysis and insight into these performance results. Table IV-2.1 summarizes the performance of the equity mutual funds which is examined first.

Equity Mutual Funds

Ranking of Performance Results

Table IV-2.1

Fund Number	Mutual Fund Name	Mean Net Return	Standard Deviation	Sharpe's Ratio	Sharpe's Rank
28	BULL & BEAR GOLD INVESTORS	(0.582)	4.822	(0.225)	94
91	LEXINGTON GOLDFUND	(0.628)	5.611	(0.202)	93

Equity Mutual Funds

Ranking of Performance Results

Table IV-2.1

Fund Number	Mutual Fund Name	Mean Net Return	Standard Deviation	Sharpe's Ratio	Sharpe's Rank
26	BRUCE	0.765	5.364	0.049	92
27	BULL & BEAR FINL. NEWS COMP.	0.752	4.152	0.060	91
35	COLONIAL SMALL STOCK A	0.863	4.966	0.072	90
15	AMERICAN HERITAGE	0.985	6.404	0.075	89
90	LEPERCQ-ISTEL	0.728	2.841	0.079	88
18	ARMSTRONG ASSOCIATES	0.792	2.985	0.096	87
23	BOSTON CO. CAP.APPREC.RETAIL	0.908	3.944	0.103	86
9	ALLIANCE TECHNOLOGY A	1.288	7.261	0.108	85
21	BEACON HILL MUTUAL	0.915	3.656	0.112	84
56	ENTERPRISE GROWTH & INCOME	0.887	3.249	0.118	83
52	DREYFUS STRAT. INVESTING A	0.950	3.637	0.123	82
29	BULL & BEAR SPECIAL EQUITIES	1.483	7.858	0.125	81
44	DELAWARE DECATUR I	0.948	3.508	0.127	80
64	FIRST AMERICAN STOCK	0.973	3.679	0.128	79
59	FEDERATED STOCK	1.012	3.938	0.129	78
94	MATHERS	0.773	2.966	0.130	77
79	IAI VALUE	1.103	4.563	0.131	75
77	IAI GROWTH & INCOME	0.988	3.699	0.131	76
20	BABSON GROWTH	1.032	3.979	0.133	74
92	LEXINGTON GROWTH & INCOME	1.013	3.768	0.135	73
2	20TH CENTURY SELECT INVESTOR	1.117	4.381	0.140	72
51	DREYFUS GROWTH OPPORTUNITY	1.103	4.102	0.146	71
57	EVERGREEN	1.180	4.560	0.148	69
48	DODGE & COX STOCK	1.103	4.044	0.148	70
16	AMERICAN LEADERS A	1.047	3.597	0.151	67
40	COMPOSITE GROWTH	1.010	3.355	0.151	68
14	AMERICAN CAP. PACE A	1.118	3.970	0.155	66
49	DREYFUS	0.990	3.091	0.157	65
25	BRIDGES INVESTMENT	0.928	2.670	0.159	64
10	AMCAP	1.213	4.334	0.164	63
87	IVY GROWTH A	1.142	3.860	0.165	62
68	FOUNDERS GROWTH	1.302	4.720	0.169	61
61	FIDELITY CAPITAL APPREC	1.130	3.653	0.171	59
17	ANALYTIC OPTIONED EQUITY	0.868	2.133	0.171	60
8	ALLIANCE GROWTH & INCOME A	1.145	3.632	0.176	55
84	IDS STRAT. AGGRESSIVE EQUITY	1.393	5.059	0.176	56
39	COMMON SENSE GROWTH & INCOME	1.148	3.668	0.176	57
67	FOUNDERS BLUE CHIP	1.157	3.719	0.176	58
42	COREFUND EQUITY INDEX A	1.187	3.830	0.178	54
89	KEYSTONE AMER. EQUITY-INC. A	1.057	3.086	0.179	52
36	COLONIAL U.S. EQUITY INDEX	1.178	3.772	0.179	53
93	LINDNER	1.030	2.889	0.182	51
1	20TH CENTURY GROWTH INV.	1.543	5.652	0.184	49
55	ENTERPRISE GROWTH	1.292	4.292	0.184	50
45	DELAWARE DECATUR II	1.128	3.321	0.188	48

Equity Mutual Funds

Ranking of Performance Results

Table IV-2.1

Fund Number	Mutual Fund Name	Mean Net Return	Standard Deviation	Sharpe's Ratio	Sharpe's Rank
81	IDS EQUITY PLUS	1.215	3.763	0.189	45
30	BURNHAM A	0.927	2.238	0.189	46
38	COMMON SENSE GROWTH	1.302	4.229	0.189	47
65	FORTIS CAPITAL	1.327	4.320	0.190	44
70	FUNDAMENTAL INVESTORS	1.243	3.881	0.191	43
46	DELAWARE DELCAP	1.452	4.934	0.192	42
60	FIDELITY	1.172	3.462	0.193	40
66	FORTIS FIDUCIARY	1.420	4.755	0.193	41
76	GROWTH FUND OF AMERICA	1.377	4.356	0.200	39
31	CARDINAL	1.165	3.283	0.201	37
12	AMERICAN CAP. COMSTOCK A	1.258	3.757	0.201	38
85	IDS STRAT. EQUITY	1.277	3.820	0.202	35
86	INVESCO DYNAMICS	1.587	5.369	0.202	36
37	COLUMBIA GROWTH	1.298	3.918	0.203	34
13	AMERICAN CAP. ENTERPRISE A	1.377	4.281	0.204	32
33	COLONIAL A	1.140	3.122	0.204	33
71	G.T. AMERICA GROWTH A	1.705	5.817	0.206	31
34	COLONIAL GROWTH SHARES A	1.392	4.291	0.207	30
74	GENERAL ELEC. S&S PROGRAM	1.255	3.602	0.208	29
63	FIDELITY VALUE	1.333	3.959	0.209	27
62	FIDELITY TREND	1.487	4.707	0.209	28
50	DREYFUS APPRECIATION	1.327	3.914	0.210	25
11	AMERICAN AADVANTAGE EQUITY	1.267	3.640	0.210	26
83	IDS STOCK	1.202	3.296	0.212	24
75	GENERAL SECURITIES	1.180	3.158	0.214	23
80	IDS DISCOVERY	1.660	5.370	0.215	22
6	AIM WEINGARTEN	1.517	4.676	0.217	21
58	FEDERATED GROWTH	1.522	4.666	0.218	20
69	FOUNDERS SPECIAL	1.680	5.373	0.219	19
41	COMPOSITE NORTHWEST 50	1.675	5.262	0.223	18
53	DREYFUS THIRD CENTURY	1.310	3.579	0.225	16
82	IDS GROWTH	1.582	4.788	0.225	17
43	DEAN WITTER AMERICAN VALUE	1.437	4.107	0.227	15
24	BRANDYWINE	1.820	5.446	0.242	14
4	ACORN	1.527	4.217	0.243	13
3	44 WALL STREET EQUITY	1.403	3.680	0.244	12
78	IAI REGIONAL	1.373	3.535	0.246	10
54	ENTERPRISE CAPITAL APPREC.	1.633	4.597	0.246	11
19	BABSON ENTERPRISE	1.582	4.343	0.248	9
5	AIM CONSTELLATION	2.050	6.189	0.250	8
32	CENTURY SHARES	1.650	4.531	0.253	7
47	DELAWARE TREND	2.072	6.180	0.254	6
22	BERGER 100	1.960	5.621	0.259	5
7	ALGER SMALL CAPITALIZATION	2.202	6.055	0.280	3
72	GABELLI ASSET	1.313	2.894	0.280	4

Equity Mutual Funds

Ranking of Performance Results

Table IV-2.1

Fund Number	Mutual Fund Name	Mean Net Return	Standard Deviation	Sharpe's Ratio	Sharpe's Rank
88	JANUS	1.683	4.202	0.281	2
73	GATEWAY INDEX PLUS	1.133	1.647	0.382	1
	Average	1.223	4.172	0.172	

The results are consistent with expectations regarding both the level and variability of performance for mutual funds in general. On average, these funds provided investors with a 1.223 percent monthly net return and a level of risk of 4 172 percent, as measured by the standard deviation of monthly returns The number one ranking fund, Gateway Index Plus (73), achieved a monthly return of only 1 133 percent, yet its variability, as measured by the standard deviation of returns, was also low, at 1 647 percent, resulting in a reward-to-variability ratio of 0 382 The worst ranking funds are Bull & Bear Gold Investors (28) and Lexington Goldfund (91) which demonstrated monthly returns of -0 582 and -0 628 percent, standard deviations of 4.822 and 5.611 percent, and performance ratios of -0.225 and -0.202 respectively. Table IV-2 1 illustrates the results which could have been obtained, after commission costs, by investors using a naive, random selection strategy to construct their portfolios. The ordinal ranking is somewhat unexpected The average results show general improvement as the number of stocks included increases. However, many levels exhibit similar or identical rankings suggesting that commission schedules used by brokers are a function of not only price but also number of stocks traded Individual results are similar to those observed when commission costs were excluded. The average mutual fund performance exceeds a naive investment strategy but only for investors considering 5 stocks or less However, a comparison of Table IV-2.1 and Table IV-2.2 reveals that 59 mutual funds exceeded the 0.169 ratio achieved by the 5 stock portfolio. Furthermore, 38 funds exceeded the highest ratio of 0.200 achieved at the 25 stock level.

Performance of Equally Weighted Equity Portfolios, 1988 - 1992

Mean Net Returns

Table IV-2.2

No. of stock per portfolio	Net Mean Monthly Return %	Standard Deviation %	Sharpe's	
			Index	Rank
25	1.383	4.385	0.200	1
23	1.394	4.480	0.199	2
24	1.381	4.413	0.199	3
21	1.370	4.407	0.197	4
15	1.415	4.648	0.196	5
11	1.434	4.783	0.194	6
13	1.412	4.673	0.194	7
17	1.406	4.659	0.194	8
19	1.379	4.517	0.194	9
20	1.369	4.493	0.192	10
16	1.384	4.585	0.192	11
22	1.370	4.516	0.192	12
14	1.402	4.697	0.192	13
12	1.447	4.977	0.189	14
8	1.475	5.181	0.187	15
18	1.376	4.685	0.186	16
6	1.469	5.386	0.179	17
10	1.420	5.151	0.178	18
9	1.392	5.071	0.175	19
7	1.466	5.459	0.173	20
5	1.438	5.525	0.169	21
3	1.481	6.318	0.155	22
4	1.390	6.099	0.145	23
2	1.480	7.221	0.135	24
Average	1.413	5.013	0.181	

Illustrated below in Table IV-2.3 are the results, net of commissions, which could have been obtained by investors using the single index model to construct their optimal portfolios The ordinal ranking observed here suggests that when security covariances are explicitly considered results are mixed. Portfolios whose stock content ranges from 10 to 15 stock achieve the highest ratios and thus rank superior overall. Portfolio composition based on more than 15 stocks and less than 10 stocks achieve relatively inferior performance lending support to the contention of optimal diversification for some range of stock content. Stock levels below this range are probably insufficient to achieve minimum levels of systematic risk, which result in inefficent portfolios, whereas stock levels above this range do not contribute to

reducing risk but are costly because commissions must be paid on the total number of different stocks traded. On average, the mutual fund investment alternative, which exhibits a ratio of 0.172, is desirable only over portfolios containning 2 stocks where the average ratio for this portfolio is 0.168. Above this level, direct investment strategies exceed the average mutual fund performance. A further comparison of Table IV-2.1 and Table IV-2.3 reveals that only 4 mutual funds exceeded the highest ratio of 0.273 acheived by the 25 stock portfolio.

Performance of Single Index Model Equity Portfolios, 1988 - 1992

Mean Net Returns

Table IV-2.3

No. of stock per portfolio	Net Mean Monthly Return %	Standard Deviation %	Sharpe's	
			Index	Rank
10	1.296	2.902	0.273	1
12	1.215	2.651	0.268	2
8	1.363	3.249	0.264	3
19	1.023	1.990	0.261	4
13	1.130	2.430	0.258	5
14	1.096	2.307	0.257	6
15	1.079	2.248	0.256	7
11	1.180	2.688	0.251	8
21	0.953	1.795	0.250	9
16	1.041	2.177	0.247	10
9	1.246	3.015	0.246	11
23	0.922	1.712	0.244	12
25	0.900	1.624	0.244	13
22	0.941	1.799	0.243	14
18	0.987	2.004	0.241	15
17	0.997	2.048	0.240	16
6	1.429	3.854	0.240	17
7	1.380	3.656	0.240	18
24	0.915	1.722	0.239	19
20	0.950	1.907	0.234	20
5	1.453	4.131	0.230	21
4	1.535	4.855	0.212	22
3	1.650	5.794	0.198	23
2	1.598	6.533	0.168	24
Average	1.178	2.879	0.234	

Finally, Table IV-2.4 illustrates the results which could have been realized by investors, net of commissions, using the Markowitz's mean-variance criterion model to select the optimal investment proportions for construction of their portfolios. The ordinal ranking is consistent

with the results when no commissions are considered. However, they differ from the ordinal ranking of the other portfolio approaches when commssions are considered. In this instance, investors who consider only two stocks for potential investment would be indifferent between an investment in mutual funds and an investment in a mean-variance efficient equity portfolio derived using the Markowitz model. Comparing results in Table IV-2.1 and Table IV-2.4 we find that 34 mutual funds actually exceeded the average two stock portfolio ratio of 0.172. Overall, not one mutual fund was able to obtain a level of performance which surpassed the level achieved by a 25 stock portfolio

Performance of Mean-Variance Efficient Equity Portfolios, 1988 - 1992

Mean Net Returns

Table IV-2.4

No. of stock per portfolio	Net Mean Monthly Return %	Standard Deviation %	Sharpe's Index	Sharpe's Rank
25	3.917	4.985	0.685	1
24	3.933	5.422	0.644	2
23	3.542	4.790	0.634	3
22	3.964	5.662	0.611	4
21	3.381	4.835	0.595	5
20	3.249	4.785	0.574	6
19	3.065	4.604	0.556	7
18	3.025	4.797	0.526	8
16	3.053	5.193	0.491	9
15	2.918	4.921	0.491	10
17	2.760	4.611	0.489	11
14	2.920	5.178	0.467	12
13	2.704	5.005	0.440	13
12	2.691	5.030	0.435	14
10	3.037	6.009	0.422	15
11	2.872	5.787	0.409	16
8	2.384	5.136	0.366	17
9	2.193	4.891	0.345	18
7	2.237	5.476	0.317	19
6	2.087	5.330	0.297	20
5	1.837	5.031	0.265	21
4	1.897	5.850	0.238	22
3	2.052	7.335	0.211	23
2	1.686	6.862	0.172	24
Average	2.811	5.314	0.434	

CHAPTER VI

SUMMARY AND CONCLUSIONS

Although previous studies have provided empirical evidence to support the contention that mutual funds typically exhibit results which are not superior to that of an unmanaged portfolio, the normative inferences drawn from such evidence regarding the desirability of investing in mutual fund shares raises an important issue which remains unresolved Can rationale be offered for the popularity and unprecedented rate of growth of mutual funds

Performance evaluation measures based on CAPM theory were reviewed and their potential limitations examined. Essentially, performance measures seek to reduce the two parameter risk-return dimensions related to investment performance to a singular measure which incorporates the rate of return adjusted for risk Despite a consensus on the appropriate measure for investor reward - the average rate of return, there remains disagreement on the measure for quantifying risk and consequently establishing normal performance Sharpe's measure is deemed appropriate when investors are assumed to invest in the shares of a single mutual fund or when the level of diversification is insufficent to reduce the unsytematic risk contained in a portfolio to a minimum.

Two portfolio selection models based on CAPM theory were detailed A random approach to portfolio selection was also outlined. The distinct advantage of the Markowitz formulation stems from its explicit recogniton of the covariances between securities The model, however, requires not only the calculation, but also the inversion, of a full variance-covariance matrix for all pairwise terms. This imposes computational difficulties especially when the number of securities under consideration is large. The single index model attempts to

reduce computational requirements through an assumption of the relationship between security returns and their dependence on an overall market index The various portfolio selection approaches provide a theorectical tradeoff between exactness in representing the underlying security relationships against the relative ease of formulation, manipulation and level of user sophistication, as well as savings in computional time and cost. Consequently, these approaches might easily be used by investors with various levels of knowledge and financial sophistication

Finally, the impact of the index selected to represent the market was discussed Theorectically, the market portfolio contains all marketable securities in the exact proportions in which they are supplied under conditions of equilibrium The single index model measures the expected return and variance of securities by relating a given security's return to that of the market as represented by an index of market activity For virtually every index there is a beta for each asset / portfolio, these betas can and usually are different for most indices.

Investors deciding between the alternatives of investing in mutual fund shares and a direct investment in common stocks must examine and compare the professional management expenses incurred by the fund with the degree to which the funds in question have succeeded in achieving the following two common objectives·

(1) to increase returns through active professional management of the assets within a portfolio and through the exploitation of economies of scale and;

(2) to reduce the level of investment risk through efficient diversification of the portfolio.

The evalution of a particular mutual fund's performance usually necessitates comparing the fund's average risk adjusted return with that of investments randomly chosen from the stock market The recognized method of conducting such an evaluation requires comparing

the mutual fund's risk adjusted return with the risk adjusted return of a common index such as the S&P 500 or Dow-Jones Industrial Average

This study recognizes that as a result of market imperfections and the indivisibility of securities a reali, : and plausible alternative to investment in mutual funds is a direct investment in a small portfolio of individual common stocks. It is this attainable alternative, not a market index, which should be used as a basis for comparison

To test this hypothesis, random equity portfolios based on each of the three previously outlined formulation approaches were created and compared to the performance of the equity mutual funds The comparisons were performed based on average results, both gross and net of commssion costs, as well as for the results achieved by individual funds and stock portfolios

Based on the analysis in which commission costs are not explicitly recognized the results obtained suggest that, in general, for investors who are prepared to diversify their investment portfolio among only a few number of equity securities the preferred investment choice is mutual funds. However, as the number of common stocks considered for potential investment increases the preferred investment becomes a direct investment in equity shares The level at which a direct investment in common stocks becomes more desirable to the investor than the purchase of mutual fund shares is related to the formulation model employed to select the optimal portfolio proportions and whether commission costs are included When the analysis gives recognition to commission costs, the results obtained are similar to those obtained when commission costs are excluded The evidence suggests that for instances where investors are seeking to diversify their investment portfolio among only a very few number of equity securities the optimal decision, based on terminal wealth, is an investment in mutual funds The stock level at which this decision becomes undesirable to the investor is reduced

when transaction costs are deducted This is partly related to the commission cost schedules employed by brokerage firms to effect security trades for their clients Ceteris Paribus, the greater the number of different stocks which must be bought and sold, even in an buy-and-hold strategy, the larger the overall commission paid. This results in a both a lower initial investment and lower proceeds upon disposition of the shares at the investment horizon. The impact of discount brokers. which have penetrated this market to a moderate degree, and the costs they charge their clients would likely have a small impact on the results found in this study. That is, the introduction of discount broker commission schedules would likely increase, albeit to a small degree, the stock level at which mutual fund shares are more desirable. However, since a significant proportion of investors still use investment brokers when trading shares the use of their commission schedules is a reasonable basis for estimating net returns.

This study provides a basis for future research There are several limitations to this study which impact on the potential to generalize based on these results First, mutual funds operate under operating restrictions in terms of the ability to invest. Regulations, for example, restrict the maximum ownership of specific securities. Second, mutual funds are not permitted to short sell equity securities The portfolio formulation approaches used to create optimal portfolios in this study permit short selling of securities. Furthermore, the level of investment for a particular security is unrestricted Finally, the study concentrates exclusively on equity securities These limitations could be overcome by (1) developing a model which restricts ownership of a security to some reasonable limit, (2) disallowing short selling in the optimal portfolio formulation, and (3) expanding the investment universe to include not only various types of mutual funds but also other assets, such as bonds, options, warrants, real estate, commodities, and non traditional assets (i e. coins, paintings, etc.). These changes in

methodology and scope would more closely approximate the constraints facing investors, both mutual fund managers and average investors, and thus expand on this study's findings.

Endnotes

[1]For example, see Treynor, J.L., and Mazuy, K.K., "Can Mutual funds Outguess the Market," Harvard Business Review, 1966.

[2]Friend, Irwin and Vickers, Douglas, "Portfolio Selection and Investment Performance," The Journal of Finance, 1965.

[3]1994 Mutual Fund Fact Book, Investment Company Institute.

[4]Jensen, Micheal C., "Problems in Selection of Security Portfolios," Journal of Finance, 1968.

[5]Friend, Irwin and Blume, Marshall, "Measurement of Portfolio Performance Under Uncertainty," The American Economic Review September 1970, pp. 561-575.

[6]For a discussion of diversification, see Evans, John L. and Archer, Stephen H. "Diversification and the Reduction of Dispersion. An Empirical Analysis, " Journal of Finance, Vol. 23, (December 1968), pp.: 761-767.

[7]Treynor appears to be the first person to perceive the concept of undiversifiable: Jack L. Treynor, "A Theory of Market Value of Risky Assets," Unpublished manuscript, 1961.

[8]The beta coefficient, $\frac{Cov(R_i, R_m)}{Var(R_m)}$ is generally calculated through the use of time series regression of the return on a security against the market return.

[9] For example, see Elton, Edwin J., and Gruber, Martin J., "Risk Reduction and Portfolio Size: An Analytical Solution," Journal of Business, October 1977, pp. 415-437.

Figure 1

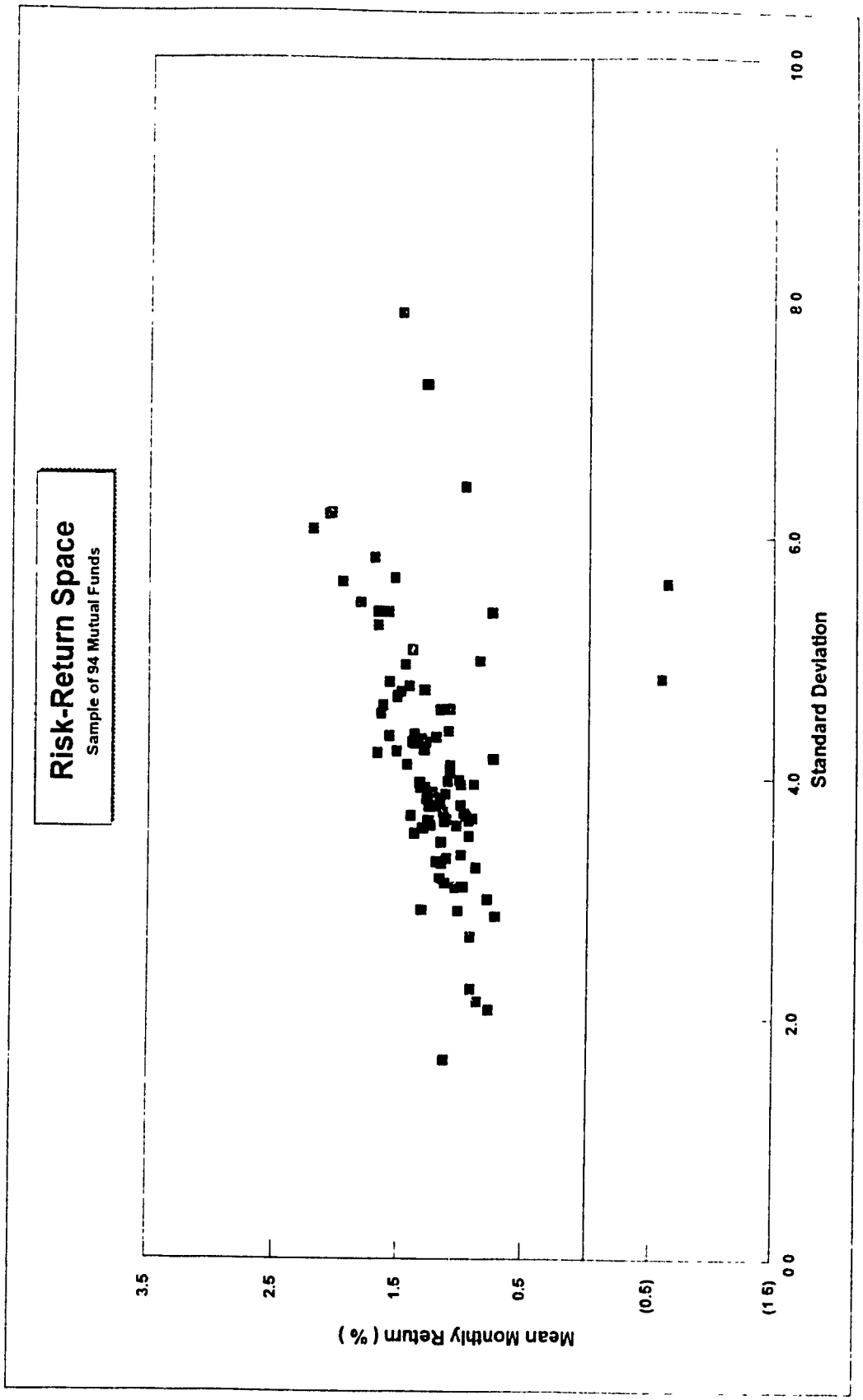

Risk-Return Space
Sample of 94 Mutual Funds
Mean Monthly Return (%)
3.5
2.5
1.5
0.5
(0.5)
(1.5)
0.0
2.0
4.0
6.0
8.0
10.0
Standard Deviation

Figure 2

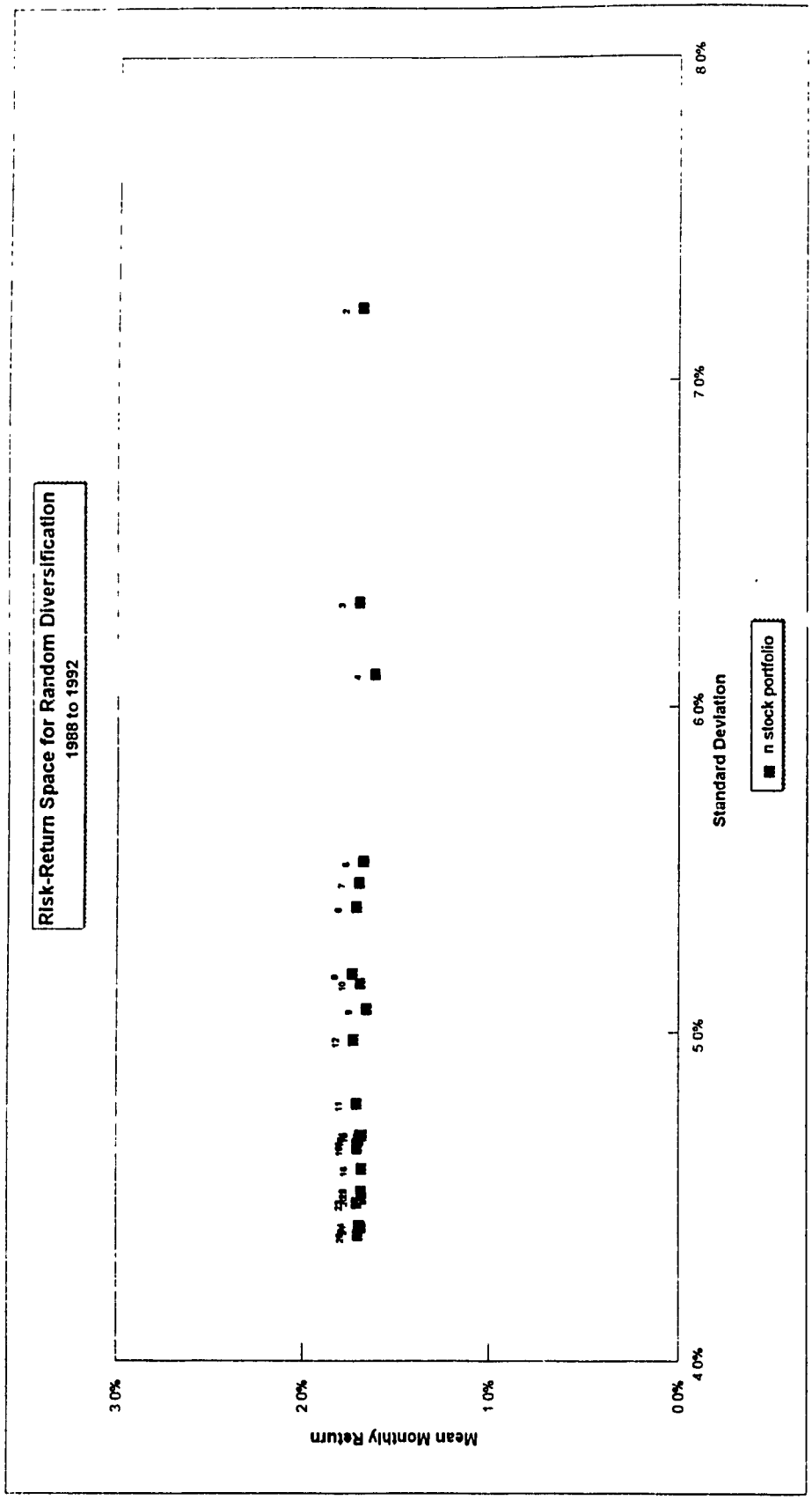

Risk-Return Space for Random Diversification
1988 to 1992
Mean Monthly Return
3.0%
2.0%
1.0%
0.0%
4.0%
5.0%
6.0%
7.0%
8.0%
Standard Deviation
n stock portfolio

Figure 3

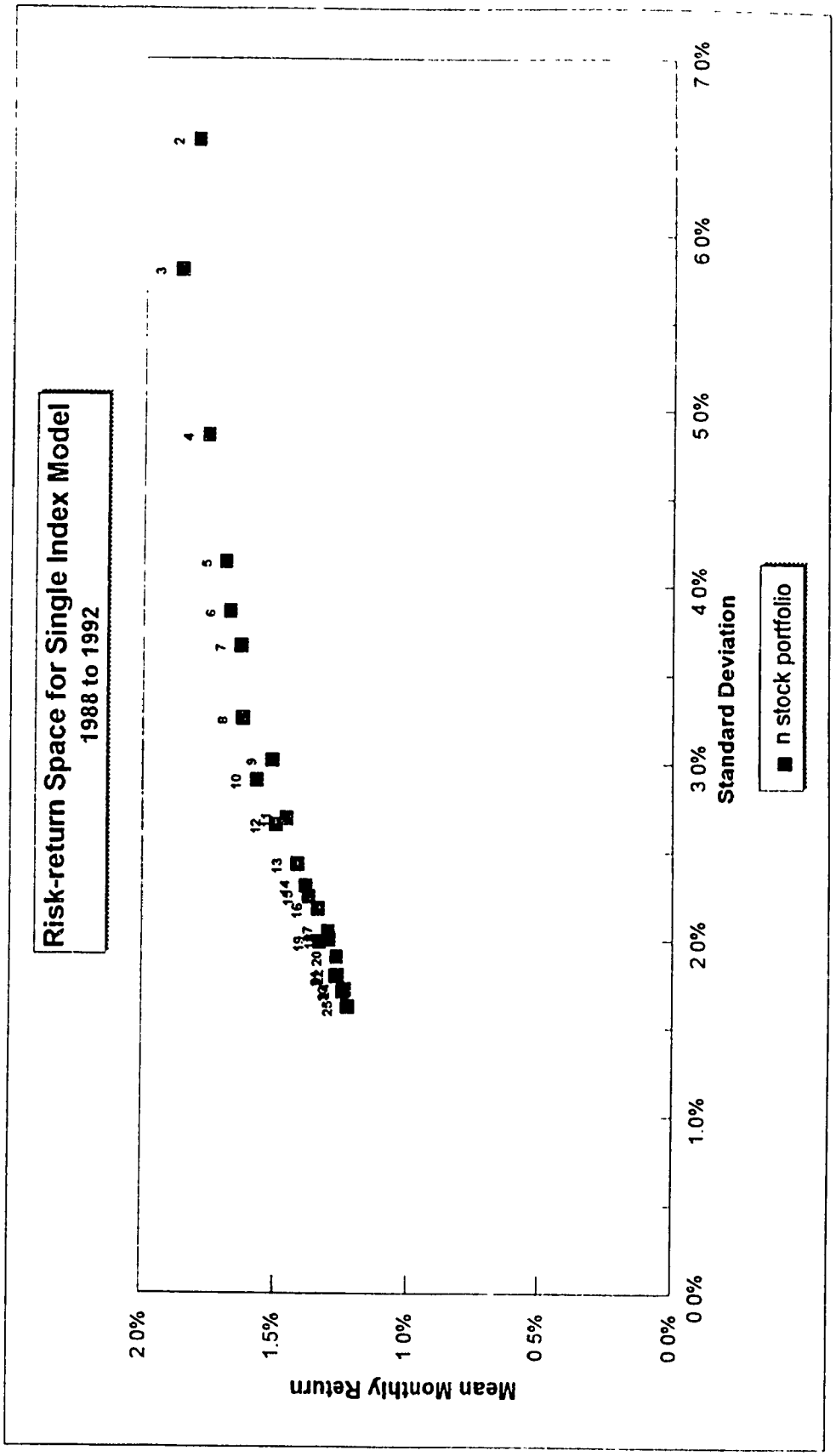

Risk-return Space for Single Index Model
1988 to 1992
Mean Monthly Return
2.0%
1.5%
1.0%
0.5%
0.0%
0.0%
1.0%
2.0%
3.0%
4.0%
5.0%
6.0%
7.0%
Standard Deviation
n stock portfolio

Figure 4

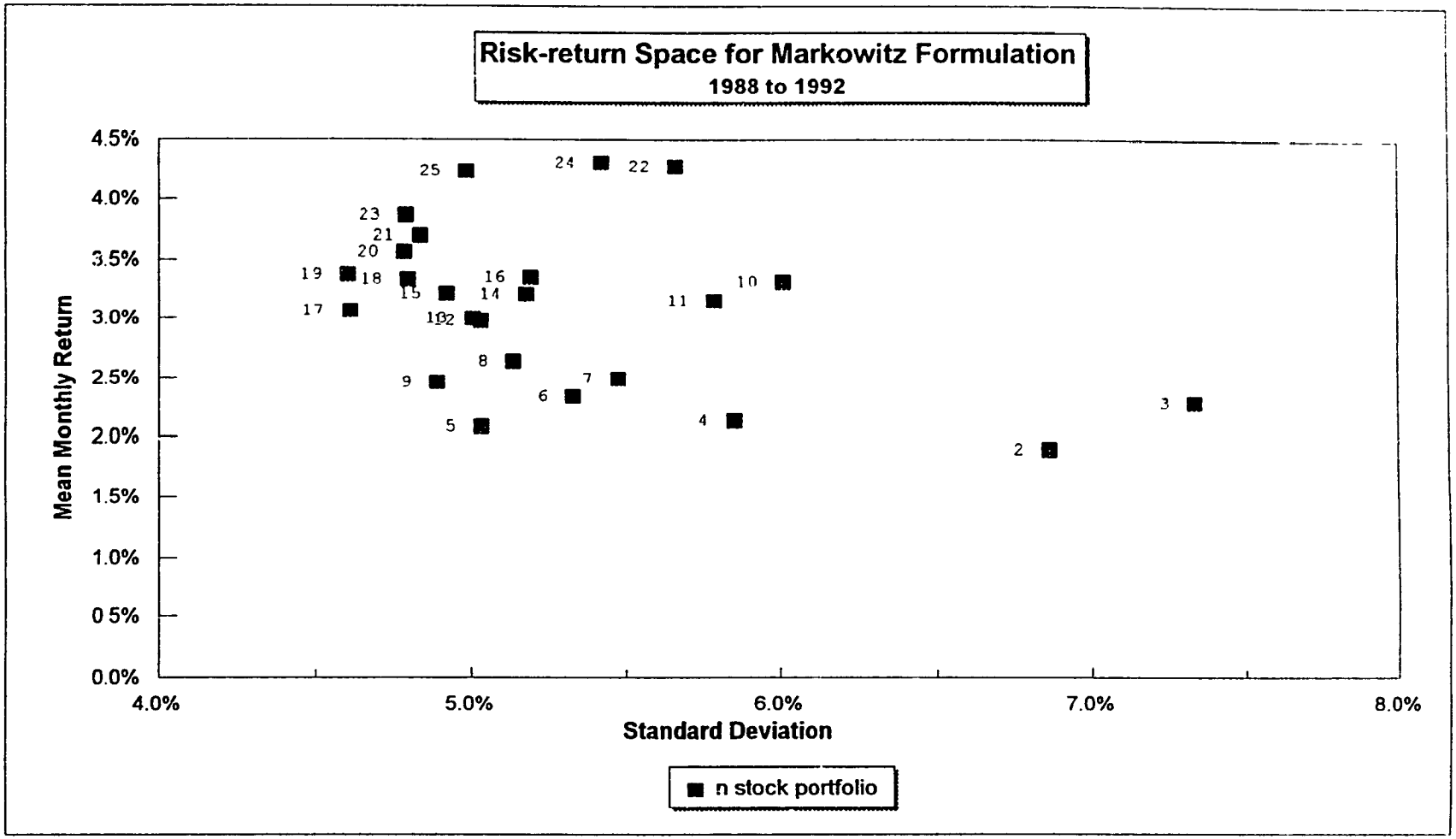
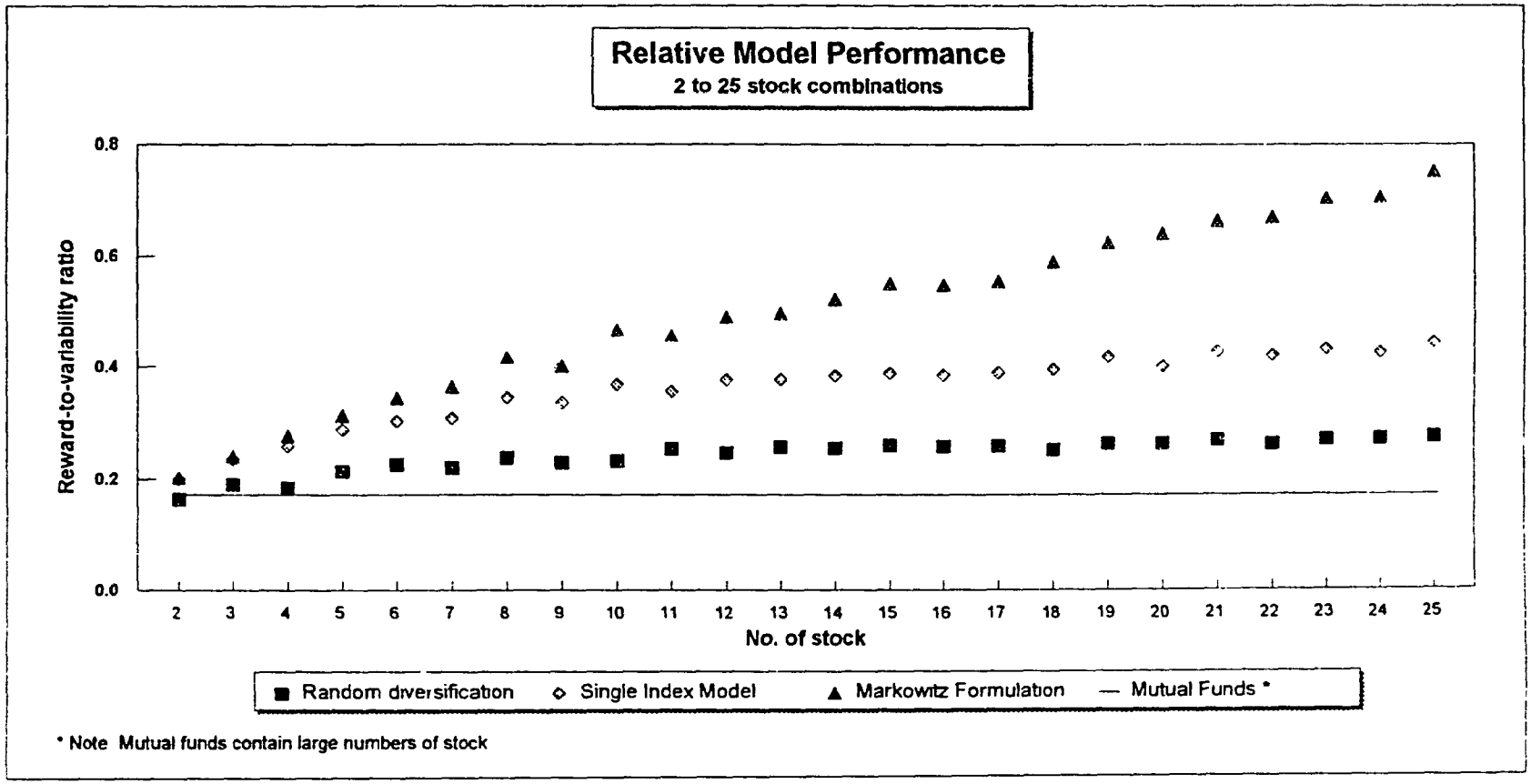

Risk-return Space for Markowitz Formulation
1988 to 1992
Mean Monthly Return
4.5%
4.0%
3.5%
3.0%
2.5%
2.0%
1.5%
1.0%
0 5%
0.0%
4.0%
5.0%
6.0%
7.0%
8.0%
Standard Deviation
n stock portfolio

Figure 5


Relative Model Performance
2 to 25 stock combinations
Reward-to-variability ratio
0.0
0.2
0.4
0.6
0.8
2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25
No. of stock
Random diversification
Single Index Model
Markowitz Formulation
Mutual Funds *
* Note Mutual funds contain large numbers of stock

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