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AN EMPIRICAL TEST OF THE RELATIVE VALUE THEORY AS AN APPROACH TO ASSET SELECTION (A case of Nairobi Stock Exchange)

BY

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DECLARATION

This research project is my original work and has not been presented for a degree in any other university.

Signed Mutunga Date: 25/10/2002

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This research project has been submitted for examination with my approval as the University Supervisor.

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DEDICATION

To my parents,
sisters and brothers, and most important, Julius, our lastborn.

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TABLE OF CONTENTS

CHAPTER THREE: RESEARCH DESIGN

CHAPTER FOUR: FINDINGS AND INTERPRETATION

CHAPTER FIVE: SUMMARY AND CONCLUSIONS

APPENDICES

REFERENCES

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

ABSTRACT

The study set out to investigate whether Investment strategy in choosing assets to include in a portfolio using geometric mean is significantly different from the one used in choosing assets to include in a portfolio using arithmetic mean if the target return is the same.

The need for the study emanated from the apparent competition between maximization of arithmetic mean of returns and maximization of geometric mean of returns. Such a competition would leave the problem of correctly choosing assets by investors unresolved and therefore very necessary to determine which of the two techniques above is better as far as maximizing returns in the long run is concerned.

Shares' historical returns were computed and both their yearly arithmetic mean and geometric mean determined using secondary data obtained from the companies' financial statements available at the Nairobi Stock Exchange. Portfolios were constructed and two efficient frontiers designed; one on the basis of the arithmetic mean and the other on the basis of the geometric mean.

The findings were that, firstly, the arithmetic mean return and geometric mean return are not statistically significantly different. This finding is strongly supported by the argument that there is an insignificant difference in the respective proportion of weights in the shares constituting the portfolios in both the geometric mean and arithmetic mean cases. Secondly, there was no shift in shares that constitute portfolios constructed based on arithmetic mean and those based on the geometric mean. During the six years under study, the geometric mean efficient frontier was found to lie below the arithmetic mean efficient frontier following higher arithmetic mean returns throughout the years than the geometric mean returns.

The combination of the above findings led to the conclusion that the investment strategy in choosing assets to include in a portfolio using the geometric mean is not significantly different from the one used in choosing assets to include in a portfolio using arithmetic mean if the target return is the same. The implication of this study is that the best asset selection approach is yet to be determined and therefore investors ought to be very careful on the measure of average return they would wish to use in future depending on their risk preferences.

CHAPTER ONE: INTRODUCTION

1.1 Background

The CAPM theory has been studied and accepted by academia and the investing community in general. This popularity would make the CAPM theory a self-fulfilling prophecy. At this point, any empirical test would do nothing but confirm the CAPM theory. Such a confirmation would be a weak proof for the CAPM being the best approach to asset valuation For this reason, there is need for an alternative or competing theory that is able to circumvent some of CAPM's weaknesses.

The above quotation is what propelled me into undertaking this study. It specifically serves as a motivation of my research study. In other words, there is no best or conclusive approach to asset valuation so far. Therefore, coming across relative theory (A relatively new theory), I felt the need to put the theory into empirical test as a way of studying it. CAPM was studied through various tests before it's wide acceptance.

In our lifetime, we earn and spend money. At times people earn more than what they spend, while at other times, they spend more than what they earn. When we earn more than we spend, then we can talk of some surplus amount of money. This is the portion of our earnings (cash), which we save and invest for future returns. The main goal behind investing is to maximize the returns earned while minimizing risk over the period during which the investment is held. Maximizing the cumulative returns in the holding period of an investment would then require various investing strategies. For the purpose of this study two competing strategies namely, geometric mean maximization and arithmetic mean maximization are assumed to be within the reach of both existing and potential investors. In investment it is reasonable to assume that a rational investor will go for that accurate and descriptive measure of average return performance. This enables him/her choose the assets correctly in order to maximize returns while minimizing risk at the same time.

Lulian S Alb (2001), proposed that rational investors allocate capital to maximize the probability-weighted geometric mean of payoffs (the geometric expected returns). The theory does not make assumptions about investor's risk preferences and explains the "risk premium" without using the utility function concept.

Lulian argued that it can be mathematically proved that maximizing the geometric expected return is the investing strategy that, over the long term will consistently outperform any other strategy in terms of cumulative returns. His assertation can be tested empirically. The argument was as follows,

The cumulative return per investing loop tends to the probability-weighted geometric mean of returns (geometric expected returns) when the number of loops tends to infinite. The proof leads to the conclusion that maximizing the geometric expected return is the investing strategy that will consistently outperform any other strategies over the long term.

In the theory it is assumed that an investor can collect the proceeds and reinvest then in the same asset over and over again. A single investment period will be referred to as an investing loop.

Considering a multi-period (of n times) investment in an asset that yields positive returns (R+) and negative returns (R-) whose likelihoods of occurrence are P+ and P- respectively during the entire investment period, then we have the results:

$$Lim\, n \to \infty \sqrt[n]{R_n} = R+^{P+}\, R-^{P-} \quad \text{--------------------} \qquad \text{(Equation 1)}$$

At the end of the investment period, this asset will have positive returns for a given number of times (periods) and negative returns for the remainder of the total investment period. As such, the total returns over the whole period of investment will be a combination of these two. This implies that

$$Rn = R+^{n+} R-^{n-} \text{ ----------------------} \qquad \text{(Equation 2)}$$

Since $\sqrt[n]{Rn} = (Rn)^{\frac{1}{n}}$ then substituting (A2) into this expression gives us the results

$$\left(R+^{n+} R-^{n-}\right)^{\frac{1}{n}} = R+^{\frac{n+}{n}} R-^{\frac{n-}{n}} \text{ --------------} \qquad \text{(Equation 3)}$$

By the use of power rules in mathematics.

Introducing limits, we have:

$$Lim\ n \to \infty \quad \sqrt[n]{R_n} = Lim\ n \to \infty\left(R+^{\frac{n+}{n}} R-^{\frac{n-}{n}} \right) = R+\left(^{Lim\ n \to \infty \frac{n+}{n}} \right) R-\left(^{Lim\ n \to \infty \frac{n-}{n}} \right) \qquad \text{(Equation 4)}$$

The above argument tries to determine the extent of the returns as the number of years of investment (investment period) become extremely many or infinite.

The likelihoods of occurrence of positive and negative returns respectively are $\frac{n+}{n}$ and $\frac{n-}{n}$, (which can be rewritten as P+ and P-) where the signs serve the purpose of distinguishing the two different returns.

From this we have the result;

$$Lim\, n \to \infty \sqrt[n]{R_n} = R+^{P+} R-^{P-}$$

Which is the required proof.

The implication of the above argument would be that, the geometric mean maximization is a better criterion for rationality than the arithmetic mean maximization. This is the theory that Lulian referred to as the relative value theory (RVT). The RVT rests on a mathematical foundation that uses two concepts; time value of money and the probability distribution of payoffs. This mathematical foundation allows the theoretical investigation of how prices are formed and market equilibrium is reached. The conclusion reached by Lulian about the RVT was that, the theory rests on a logical solid foundation, is consistent with most finance phenomenon, and provides a workable theory of investing.

In contrast to this theory, finance theory rests on the fundamental assumption that rational investors want to maximize the probability-weighted arithmetic mean of their portfolio payoffs (arithmetic expected returns). In reconciling this rationality criterion with empirical results, theorists introduce the utility function concept and assume investors are risk-averse. It is this theory, which is (and has been) in practice; the theory being challenged by Lulian.

Presented with the above two different rationality criteria, which rationality criterion should investors go for? Or are the two equally the same but only stated differently, and that, whichever an investor would go for would not matter? In answering this question we would be interested in empirically testing the suitability of the geometric mean over the arithmetic mean as a measure of portfolio performance.

Research and practice done on evaluation of investment performance have used arithmetic mean method. There has also been theoretical justification on the suitability of geometric mean in assessing investment performance. In this respect, there was need for empirical investigation on the suitability of geometric mean in the measurement of investment performance with a specific reference to portfolios of shares at the Nairobi stock exchange (NSE). In assessing the comparative suitability of these measures, different portfolios of shares were constructed, their returns, corresponding risk and efficient frontiers designed for both the arithmetic means and geometric means.

For this interest, I therefore sought to investigate the differences between the two measures of investment performance on the basis of their efficient frontiers as the central aim useful in arriving at relevant conclusions in this paper.

Reasons given by Lulian (2001) for using Geometric mean:

1. Lulian argues that the higher the geometric expected return for a portfolio, the higher its expected cumulative return. If this is true, considering that rational investors put their wealth into a collection of different assets (portfolio of assets), in order to essentially minimize risk and maximize their returns, then the geometric expected return is theoretically justified to be suitable over the arithmetic expected return in the context of maximizing cumulative returns.

2. According to Lulian, individual investors appear to be interested in investing strategies that consistently work, (such a strategy being that of maximizing the geometric expected return). This provides credibility to the theory's rationality criterion.

   Lulian goes ahead to argue that in light of the fact (idea) that, it's reasonable to assume that individual investors are primarily concerned with their own financial situation, the financial situation of others being of secondary concern. The relative value theory criterion appears reasonable. In support of the above argument, Lulian concluded that maximizing the geometric expected return benefits the individual investor whereas maximizing the arithmetic expected return benefits the investing community as a whole.

3. In support of the validity of the relative value theory, Lulian argued that the market value of any risky asset depends on the existence and nature (most importantly payoff correlation) of all other risky assets. Adding a new risky asset to the market will increase the market value of the existing assets. This effect also contributes to the market out performing the risk-free asset in periods of economic development in which new companies and new industries are born. Obviously the past century represents such a period.

The ability of the relative value theory to explain the observed "risk premium" without referring to investors' utility functions or postulating investors' aversion to risk provides more support to the theory's validity. Assets with higher arithmetic expected returns than the risk-free assets do not necessarily outperform the risk free assets in terms of cumulative returns. Consequently, the observed "risk premium (or at least most of it) is only apparent in the sense that a higher arithmetic expected return does not guarantee better performance in terms of maximizing cumulative returns.

It's for the above reasons that Lulian proposes that rational investors allocate capital to maximize the probability-weighted geometric mean of payoffs and that geometric mean maximization is a superior criterion for rationality than the arithmetic mean maximization.

1.1.1 The Findings of Lulian

1. Diversification not only decreases risk but also increases cumulative returns Lulian showed this by taking a simple illustration on two investments A and B. Given that one of the investments is better than the other, the best portfolio according to the relative value theory is some combination of the two. Lulian's argument was that, it can be verified that

allocating a higher percentage of capital to the "better of the investments" will result in a higher geometric return than allocating all capital to that investment (the better of the two).

2 There is no absolute value for assets.

Knowing the possible streams of cash flow and related probabilities is not sufficient to compute a price that all investors will agree upon. The equilibrium prices depend on the nature of the other existing assets, and that an investor will be willing to pay different prices for the same given asset depending on the correlation between cash flows of the asset and those of the investor's portfolio.

3 The required rate of return is an artificial concept

The relative value theory does not make reference to the required rate of return concept. It refers only to time value of money, which is unique and allows the present value calculation for any cash flow in the future, risky or not. Intuitively a rational, risk indifferent investor will not require a rate of return but will simply try to maximize his cumulative returns.

The foundation of this study lay entirely on the above findings, the absence of which the study would have been baseless. In order to carry out the study, the following assumptions in the theory were applied.

1.1.2 Assumptions of the relative value theory

1. Investors are rational, risk indifferent and try to maximize their cumulative returns.
2. An investor can collect the proceeds from his/her investment (asset) and reinvest them in the same asset over and over again

1.1.3 Importance of Lulian

Theoretical justifications of the theory were empirically tested, with some of the arguments holding (applicable) while others contradicting the underlying literature. This was found to be very interesting in the sense that it opens the debate for further studies particularly, tilting the traditional theory of finance to a new direction.

More important is the concept of relative value, that assets do not have an absolute value. This study did not arrive at a conclusion about this and therefore it is not yet clear, whether or not that, so far, there is no one best approach of valuing assets.

This is a challenge to the financial analysts to rigorously research further into the ways of valuing assets determine.

1.2 Statement of the problem

The problem facing the investor is one of choosing assets to include in his or her portfolio in order to maximize the cumulative returns while minimizing the risk. This problem gets pronounced when two approaches to asset selection are competing. Two such competing techniques are the arithmetic mean maximization and the geometric mean maximization i.e. investors may describe an array of asset returns on the basis of either their arithmetic mean or geometric mean or both.

A further complication is the argument that risky assets have higher arithmetic expected returns while the risk-free assets have a higher geometric expected return. This is a complication because, a risk-free asset's returns have both geometric and arithmetic means equal. How then and why does Lulian conclude that rational investors allocate capital to maximize the geometric expected return? Or simply, why choose the geometric mean and not the arithmetic mean as an average measure of asset performance?

For this reason, there is need to reconcile the two measures and determine the definite difference between them in this particular market (NSE) whose risk has not yet been determined in an attempt to validate or invalidate Lulian's theory. In relation to the above argument, this research seeks to answer the following questions.

i) Which of the two measures would give a higher value in the context of maximizing cumulative returns in the long run, or will the two measures have equal values in the long run.

ii) Is there a shift in assets that constitute portfolios constructed based on arithmetic mean and those based on the geometric mean?

In connection to the above question; could a link between the geometric mean and the long run be established for this market? Or what happens to variability in the long run? Does it increase, decrease or remain constant? There is also the problem of which of the two brokers to believe in, the geometric mean or the arithmetic mean.

This is because, to either broker the kind of measure one uses does not matter and hence the insignificance of any difference between the measures. This implication requires practical evidence whose conclusion would either validate or invalidate Lulian's theory.

This study therefore sought to resolve the above conflicting ideas by comparing arithmetic mean frontier and geometric mean frontier constructed from portfolios of shares at the NSE.

1.3 Objective of the study

To investigate whether investment strategy in choosing assets to include in a portfolio using the geometric mean is significantly different from the one used in choosing assets to include in a portfolio using arithmetic mean if the target return is the same.

1.4 Hypothesis testing

H0: Geometric mean return of portfolios of shares is not different from the arithmetic mean return of the same.

H1: Geometric mean return of portfolios of shares is different from the arithmetic mean return of the same.

1.5 Importance of the study

1. Once potential investors have been able to identify the appropriate approach of the two techniques available, they will be able to correctly choose the right assets to include in their portfolios. This way, it will be possible to maximize the returns of the portfolios If not the case, that is; if both are equally the same, then investors will have two alternatives to choose from, probably depending on the ease of use of one technique compared to the other.

2. The financial advisors will be able to correctly advise those potential investors on how to choose the right assets to include in their portfolios of investment

3. To the academia, this will open the doors for further research in this area of finance as well as pursuit of knowledge.

CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

Investments can be defined as postponed consumption. Individuals should make investment-consumption decisions in a manner that will maximize their utility. Utility here being a measure of the individual's level of satisfaction, and will vary from one person to the next (Reilly & Brown, 1997).

In the field of finance, we generally assume that individuals can maximize their utility by maximizing their wealth, where wealth can be measured by the present value of the individual's income stream or alternatively, by the present value of the amount of money the individual has available to spend or consume (Weston & Copeland, 1992).

Although the ability of professional managers to beat the market consistently over time has been questioned, the search for above-average market performers nevertheless continues.

Charles H. Dow (1897), developed the best-known measure of stock market performance Dow started to compile daily averages of share prices. The assumption underlying the Dow theory is that stock exchange index reflects all that is known about business in general and the firms whose share constitutes the index. The assertion is that market movement is more appropriate measure because patterns of performance are a combination of political events, economic growth, inflation and interest rates, which can be found to repeat themselves cyclically (Hill: 1993).

It's therefore not surprising that stock market indexes, which by definition are averages, enjoy wide following. The indices, thanks to computers, reach such "a global audience and have an important psychological impact that unquestionably, they remain a major factor, not only in capital market theory, but also in professional life" (Hill: 1993). Informed investors rely on indices in evaluation and selection of investment in securities. However, averages are calculated differently.

Investment theory proclaims that the objective of rational investors is the selection of a portfolio of financial assets, which maximize their holders utility in the form of discounted net present value of the cash flows expected to be generated by that portfolio. In other words, investors look at return and risk of a portfolio inorder to be consistent in their choice of securities (Defuso).

Because cash flows in professionally managed funds occur through time and may be independent of fund's manager decisions, returns calculations must be adjusted for intra period cash flows. This can be either, the dollar-weighted or time-weighted rate of return calculations.

The time-weighted return is considered more representative of the fund manager's performance because it's not influenced as much by cash flows over which the fund manager has no control. Dollar-weighted or time-weighted returns may be annualized using either geometric or arithmetic procedure, but the geometric procedure is considered more appropriate because it considers the compounding of funds through time. (Laderman: 1995).

Many popular media comparison of investment performance involve only the valuation of assets on the basis of their mean arithmetic returns earned by investments over previous periods, these are deficient because they do not incorporate risk in the analysis. In general, the riskiness of a portfolio will decline as the number of stocks held increases. Furthermore, investors do not look at individual assets but at a collection of assets.

Three different risk-adjusted performance measures, all derived from capital market theory, are based on the assumption that investors are risk-averse and hence these measures may be considered mean-variance decision criteria.

The Treynor measure divides the investment's beta into its excess return, the Jensen measure, ji intercept term of the regression between the investment's and the market's excess return, and the Sharpe measure divides the excess return by its standard deviation. The Treynor and Jensen measures, which are based on systematic risk, give consistent indications of performance relative to the market, but they may give different rankings of investments performance because of the way risk is incorporated.

By contrast, since the Sharpe measure include total risk, it may give contradictory information about performance when compared to the other two. If the portfolio being evaluated represents the investor's total wealth, then the Treynor measure is considered most appropriate; if the total wealth is not represented, then the Treynor measure should be used (Treynor: 1965), (Jensen: 1968), (Sharpe: 1966).

Although these evaluation measures are firmly based on capital market theory, they also suffer from assumption underlying the theory. Problems include:

i). Defining the market portfolio; which is a portfolio consisting of all stocks.

ii). The assumption of risk less borrowing rate

iii). Application to *ex ante* data (expected)

iv). Portfolios with non-normal returns distributions.

Because of these concerns, two other techniques are available for evaluating the desirability of different investments. One is the wealth maximization criterion, which states that the investor should choose the investment that maximizes the terminal value of the portfolio. This procedure is identical o the strategy of maximizing the geometric mean return of the investment (Stephen & Gary, 1993). The other is the rule of stochastic dominance developed by William (1980), which forms an efficiency criterion that requires only minor assumptions about investor utility and no restrictions about the shape of the return distribution

2.2 The Dollar Weighted Rate of Return And Time Rate of Return

The internal rate of return is dollar-weighted-rate -of return because it accounts for the timing and amount of all cash flows into and out of the portfolio. In the investment-management industry, the time -weighted rate of return is the preferred performance measure. It's not sensitive to the addition and withdrawals of funds and hence not affected by cash withdrawals and additions to the portfolio. It measures the compound rate of growth of Kshs 1, initially invested in the portfolio over a stated measurement period. Time-weighted refers to the fact that the two returns are averaged over time (Dietz & Kirschman 1990). An exact time weighted rate of return on a portfolio is computed as follows;

i). Price the portfolio immediately prior to any significance addition or withdrawals of funds. Break the overall evaluation period into sub-periods based on the dates of cash inflows ad outflows.

ii). Calculate the holding period restrung on the portfolio for each sub period.

iii). Link or compound holding period returns to obtain an annual rate of return for the year (the time weighted rate of return for the year). If the investment is more than one year, take the geometric mean of the annual returns to obtain the time-weighted rate of return over the measurement period.

The calculation of the geometric mean exactly mirrors the calculation of a compound rate of growth. This mean exists only if all the observations are greater than or equal to zero and as long as we use $(1+r_t)$, the observations will never be negative because the biggest negative return is -

100 percent. The term $(1+r_t)$ represents the year ending value relative to an initial unit of investment at the beginning of the year (Stephen & Gary, 1993).

2.3 Comparison of The Geometric Mean and The Arithmetic Mean

The geometric mean will always be less than or equal to the arithmetic mean, because of a mathematical result known as Jensen's inequality (Royden, 1968). Jensen's inequality (The source of the difference between the geometric mean and the arithmetic mean), states that if a function g(x) is convex (or concave) over the region of the x-values, then;

$E[g(x)] \geq E[E(x)]$ for *convex* functions

$E[g(x)] \leq E[E(x)]$ for *concave* functions

The arithmetic mean and geometric mean are both functions of the risk of the returns. Their values depend on the level of risk, and as such, as the level of risk increases (or decreases) the geometric mean decreases (or increases) while the arithmetic mean increases (or decreases). Therefore the geometric mean is a decreasing function of risk while the arithmetic mean is an increasing function of risk. By this argument, the geometric mean is a concave function whose maximum value is at the point where the risk level is zero and hence bounded above (has an upper limit). On the other hand the arithmetic mean is a convex function and has a minimum value when the risk of returns is zero and therefore has a lower limit. In other words, the maximum value of the geometric mean is equal to the minimum value of the arithmetic mean. The above argument is supported by the fact that the second derivative of the geometric mean function is negative (less than zero) and that of the arithmetic mean is greater than zero. In general the difference between the two means increases with the variability in the period-by-period observations (Stephen &Gary, 1993). The only time that the two means will be equal is when there is no variability in the observations; that is, when all the observations in the series are the same. Arithmetic and geometric means both have a role to play in investment management. They are often reported for return series.

2.4 Using Geometric Mean and Arithmetic Mean

The geometric mean is appropriate for making investment statements about past performance The arithmetic mean is appropriate for making investment in a forward-looking context.

For reporting historical returns, the geometric mean has considerable appeal because it is the rate of growth or return we would have had to earn each year to match the actual, cumulative investment performances. It is therefore an excellent measure of past performance

In reporting historical results, researchers often present real returns in addition to nominal returns. Real returns adjust for the effects of inflation. Dimson, Marsh and Staunton (2000), reported the geometric mean of nominal U.S returns as 10.3 percent over the 20th century and the geometric mean of inflation rate over the same period as 3.2 percent. Thus they reported the geometric mean of the real returns as 6.9 percent.

As a corollary to using the geometric mean for performance reporting, the use of semi-logarithmic rather than the arithmetic scales can provide a realistic picture when graphing past performance.

A semi-logarithmic scale is the use of a logarithmic scale on a vertical axis and an arithmetic scale on the horizontal axis. The vertical axis values are spaced in accordance with the difference between these logarithms. As a result 1, 10, 100 and 1000 are equally spaced because the difference in their logarithms is roughly 2.30 that's $\ln 10 - \ln 1 = \ln 100 - \ln 10 = \ln 1000 - \ln 100 = 2.30$, on a semi-logarithmic scale, equal movements on a vertical axis reflect equal percentage changes (Campbell, 1974).

In addition, to reporting historical performance, financial analysts need to calculate expected equity risk premiums in a forward-looking context. For this purpose, the arithmetic mean is appropriate.

In contrasting the geometric and arithmetic means for discounting future cash flows, the essential issue concerns uncertainty.

Uncertainty in cash flows or returns causes the arithmetic mean to be larger than the geometric mean. The geometric mean return approximately equals the arithmetic return minus a half the variance of return. Zero variance or uncertainty in return would leave the geometric and arithmetic return approximately equal, but real world uncertainty presents an arithmetic mean return larger than the geometric (Bodie, Kane & Marcus: 1999). This is expressed as $A=G+1/2N^2$ where A is the arithmetic mean, G is the geometric mean and N^2 is the variance of returns.

The maximization of the geometric mean criterion is used to evaluate investor preferences for different portfolios if the investor's utility is not quadratic or if returns distributions are not normal. This procedure is based on less restrictive assumptions about utility and assets returns. The wealth maximization criterion indicates that the investor should choose the portfolio that maximizes expected terminal wealth. This criterion argues that the investor, regardless of his utility preferences, should choose a portfolio that has the greatest expected geometric mean returns over time. Year to year fluctuations in the portfolio's value (i.e. variance in return) are important only in that they may affect the portfolios terminal wealth

The geometric mean as a multi-period measure of expected returns incorporates risks in its calculations because its value is directly related to the variability in the time series of returns The same is not true for the arithmetic mean (A), which is defined as the average return earned over a period of investment and expressed as

$$A = (r_t + r_{t-1} + \ldots\ldots\ldots + r_T) / T = 1/T \sum_{i=1}^{T} r_i \qquad \text{(Equation 5)}$$

The geometric mean (G), on the other hand, is the T^{th} root of the product of T terms expressed as

$$G = \left[(1 + r_t)(1 + r_{t+1}) \ldots\ldots\ldots (1 + r_T)\right]^{1/T} - 1.0 = \left[\sum_{t=1}^{T} (1 + r_t)\right]^{1/T} - 1 \qquad \text{(Equation 6)}$$

The relationship between the geometric mean and the terminal wealth can be seen by expressing terminal wealth w_t as a function of the beginning wealth w_o and the returns earned over the investments periods as follows:

$$W_t = w_o(1+r_t)(1+r_{t+1}) \ldots\ldots\ldots\ldots (1+r_T) \qquad \text{(Equation 7)}$$

The value of w_t will be maximized by choosing the portfolio each period that has the greatest return.

From the expression;

$$w_T . w_o = (1+r_t)(1+r_{t+1}) \ldots\ldots\ldots\ldots\ldots\ldots (1+r_T) \qquad \text{(Equation 8)}$$

r_t in this case is the rate of return earned in period t

It's clear that maximizing the geometric mean is equivalent to maximizing the end of period wealth.

The geometric mean always will be less than the arithmetic mean of a sequence unless all values are the same, in which case the two means will be equal. The higher the variability in the yearly returns, the greater the divergence between the arithmetic means and the geometric mean values The geometric mean is said to incorporate risk by becoming smaller, relative to the arithmetic mean as time series of returns variability increases. The geometric return is appropriately applied to time series of returns because it reflects cumulative investment performance over time. whereas the arithmetic returns is best used to describe the central tendency of a return distribution at a point in time.

The wealth maximization criterion is not utility based and does not have as an objective the maximization of expected utility. However, because of its basis on the geometric mean. the wealth maximization criterion is equivalent to maximizing the expected value of a log utility function.

Several researches have compared the portfolio selected by the wealth maximization criterion to standard mean-variance analysis and made the following observation First. portfolios that are mean variance efficient may have low geometric mean returns, and portfolios with high geometric means tend not to lie on the efficient frontier Second, Elton and Gruber (1974) showed that the portfolios that maximize the geometric mean return will lie on the efficient frontier if the portfolio returns are log-normally distributed. Then the portfolio in the efficient set that meets the wealth maximization criterion can be easily identified.

A random variable, y, follows a lognormal distribution, if its natural logarithm lny, is normally distributed. The two most noteworthy observations about the log normal distribution are that. it is bounded below by zero and is skewed to the right. Asset prices are bounded from below by zero In practice, the log normal distribution has been found to be a usefully accurate description of the description of prices for many financial assets (Stephen & Gary, 1993)

Ibbotson and Sinquefield (1982) argued that for many different random events in nature, a particular frequency distribution, the normal distribution (or bell curve) is useful for describing the probability of ending up in a given range. The usefulness of this kind of distribution stems from the fact that it is completely described by the average and standard deviation. Therefore it is enough to observe that the returns are at least roughly normally distributed

Like the normal distribution, the log normal distribution is completely described by two parameters. The two parameters are the mean and standard deviation (or variance) of its associated normal distribution. The expressions for the mean and variance of a lognormal variable are summarized below, where (μ) and (N^2) are the mean and variance of the associated normal distribution. The mean of a lognormal random variable = exp (μ +0.5 N^2) and the variance is expressed as ;

$\text{Exp}\,(2\mu + N^2).(\exp(N^2) - 1)$.

The link between end-of-period wealth and an initial dollar of investment is the rate of return If end of year wealth is known with certainty, then so is the present value of the investment and the rate of return.

2.5 Portfolio theory

The fundamental goal of portfolio theory is to optimally allocate your investments between different assets. Mean variance optimization (MVO) is a quantitative tool, which will allow you to make this allocation by considering the trade-off between risk and return (Markowitz, 1991).

John Lintner (1965), on the choice of possible portfolios of stocks says that in deciding which portfolio of stock to hold, the investor will use his judgment (probability distribution) regarding the prospects of each candidate stock (and their co variances or correlations of outcomes). The investor then examines the expected return, the standard deviation of the returns and the θ ratios, which are implied by various possible portfolio mixtures of the stock. The best portfolio for him will be the one with the highest θ ratio. He will distribute any funds he invests in stocks according to the weights used in finding the portfolio with largest θ, and after these proportionate weights are found, he can then decide " how much", he wants to invest in this best portfolio mix (and how much to put in savings deposit or borrow) on utility grounds where; $\theta = (r\text{-}rf) / N_r$, and r is the portfolio expected return, rf is the risk free rate of return and N_r is the portfolio standard deviation of returns. Under real-world conditions, combining stocks into portfolios reduces risk but does not eliminate it completely.

Marshall E. Blume and Irwin Friend (1973), in testing the capital asset theory concluded that the theory does not adequately explain differential returns on financial assets. Their evidence points to segmentation of markets as between stocks and bonds, even though there are few legal restrictions, which would have these effects. They continue to argue that, until such segmentation vanishes, if it does indeed exist, and until more comprehensive and more satisfactory theories (and returns-generating models are developed), the best and safest method to formulate the risk-return tradeoff is to estimate it empirically over the class of assets and the period of interest.

Markowitz (1995), theorized how a rational investor requiring an optimal portfolio of investment could maximize utility. He defined an efficient portfolio as one that maximizes expected return for its given risk or minimizes risk for its expected returns. The expected return is measured by arithmetic mean and the risk by standard deviation. Markowitz went ahead to explain that at any given time, there would be a number of portfolios that satisfy mean-risk trade-off.

2.6 Concluding Remarks

Could stocks be combined in such a way that the resulting portfolio risk is negligible (close to zero), whose implication would be that the arithmetic mean of returns and geometric mean of returns are not significantly different and hence the issue of superiority does not arise.

Holding the level of risk constant, (which is almost impossible in a multi-period context, where we expect some upwards and downwards movements depending on the economic cycle in a particular environment), as one maximizes the arithmetic mean of the same returns, he/she will also be trying to maximize the geometric mean of the same returns. On the other hand, given the existence of risk (which is the case the world over today), as the level of risk goes up, the arithmetic mean of returns increases while the geometric mean of the same return decreases.

The question remains, is there some point in time, where the risk level of returns tends (or will) stabilize? Because the argument would be that, it's at this point that the geometric mean of returns would be maximized, thus making Lulian's argument valid. The same question brings out the gap that both Lulian and the preceding studies did not fill; as well as a contradiction due to the fact that, constant risk level does not necessarily mean zero risk level, constant here implying non-movement either upwards or downwards.

2.7 Summary of Literature Review and How it Relates with the Current Study:

Studies captured in this paper have been able to;

i) Identify the suitable context in which each measure, (geometric and arithmetic mean) is applied in terms of time measurement and state.

ii) Show that there is actually a difference in two measures above, only that this difference has not been documented to be either significant or insignificant

Though it's clear from (i) above when the geometric and arithmetic mean are individually appropriate, there is no information provided so far on which of the two would give better results (a higher average return) if and when both are subjected to the same conditions. This is the gap that this study attempted to bridge in testing the underlying theory.

Point (ii) above provided the stepping-stone for the current study. It is in fact from this point that we develop our objective. We only need to test the difference and show that it's either significant or insignificant. The significance or insignificance of the difference in this market (NSE) will form the basis of the applicability of the theory, in the sense that, the measure that one uses in calculating average returns (geometric or arithmetic) will matter if there is a significant difference. On the other hand, the measure used will not matter if the difference is found to be insignificant hence, validating or invalidating the theory.

CHAPTER THREE: RESEARCH DESIGN

3.1 Research Methodology

3.1.1 Research design.

A survey of quoted companies was carried out for the period between March 1996 to December 2001.

3.1.2 Population of the study

This was based on all limited liability companies operating between March 1996 to December 2001. This is because limited liability companies prepare annual accounts regularly which are audited by external auditors, adding to their credibility and therefore worth carrying out research on such companies

3.1.3 Sample frame.

The sample selected consisted of 18 companies that make up part of the 20 share index on the NSE. (Between march1996 to December 2001). The other two companies were left out because of their inconsistency; in the sense that Kenya Airways had not been trading in the stock exchange for the first few weeks considered in this analysis while the other company (African lakes) was not part of the 20-share index until sometimes in 2001. This sample was chosen because these companies performance represent approximately 80% of the entire market (Odera, 2000).

3.1.4 Data collection

The study made use of secondary data. This method was chosen because of the availability of data on the NSE. For each company the share prices at the beginning and at the end of every week were collected for approximately six years (March 1996 to December 2001).

3.1.5 Data analysis

Every share's return was determined by use of the shares' price i.e. the difference between ending price (P1) and the beginning price (P0) and the dividends expressed as a fraction of the beginning price as follows;

R_t= (P1-P0)/P0 (historical returns or capital gains)+D1/Po (income distributions). This was done on weekly basis for the entire period of study. Once all the weekly returns for each share were computed, then both the arithmetic mean return and the geometric mean return for each share were determined and compared. Each share's risk of the returns was also determined.

By use of SAS statistical package, the weights to be assigned to each share included in a given portfolio in order to determine different returns and risks of the portfolios were determined. Different portfolios were constructed and their returns and risk computed for the period of the study using Markowitz quadratic approach. The portfolio return and risk were computed as follows;

3.2 Portfolio Return and Risk

In the general case, where any combination of available securities may be held in the portfolio, the formulas determining portfolio expected return and standard deviation are;

$$E(R_p) = x_1 E(R_1) + x_2 E(R_2) + \ldots\ldots\ldots + x_n E(R_n) = \sum x_i E(R_i) \qquad \text{(Equation 9)}$$

Where,

$E(R_p)$ =The portfolio expected return

$E(R_i)$ =The expected return of share I

X_i = The proportion of total wealth invested in the ith share

And ;

$$\sigma(R_p) = \left(\begin{array}{l} x_1^2\sigma(R1)^2 + x_2^2\sigma(R2)^2 + \ldots\ldots\ldots\ldots + x_n^2\sigma(Rn)^2 + x_1x_2\mathrm{cov}(R_1,R_2) + x_1x_3\mathrm{cov}(R_1,R_3) + \\ \ldots x_2x_1\mathrm{cov}(R_1,R_2) + \ldots\ldots\ldots\ldots + x_nx_{n-1}\mathrm{cov}(Rn,Rn-1) \end{array} \right)$$

The above expression can be rewritten as;

$$\sigma(R_p) = \left[\Sigma\, x_i^2\sigma(Ri)^2 + \Sigma\Sigma\, x_ix_j\,\mathrm{cov}(R_i,R_j) \right]^{1/2} \qquad \text{(Equation 10)}$$

where;

$\mathrm{cov}(R_i, R_j)$ is a measure of the co movement of returns between the ith and jth share, which leads to the development of the covariance matrix.

$\sigma(R_p)$ is portfolio risk and x_i is the proportion of total investment in the ith share

3.3 Measures of The Co Movement of Returns

The dependence of returns or the degree of co movement among securities is an important consideration in the risk-reducing attributes of portfolios. The co movement influences the portfolio's risk, or its standard deviation. In this study the covariance was used as the measure of co movement among the securities.

By definition the covariance between two security returns, r_i and r_j, is the expected value of the product o f the way the returns deviate from their own expected values, calculated as;

$$Cov(r_i, r_j) = 1/T\sum_{i=1}^{T} (r_{it} - Er_i)(r_{jt} - Er_j) \qquad \text{(Equation 11)}$$

Where r_{it} and r_{jt} are the returns for securities (shares) i and j respectively in period t.

Efficient frontiers were designed using both the arithmetic and the geometric mean methods for a predetermined level of return. The predetermined level is identified for both arithmetic and geometric mean. Arriving at both efficient frontiers called for the mean-variance optimization approach. The portfolios' returns and variances were used to develop the opportunity set that led to the construction of the efficient frontier. Comparisons were made on the optimal portfolios achieved by both methods.

CHAPTER FOUR: FINDINGS AND INTERPRETATION

4.1 Introduction

Since the research was aimed at comparing the efficient frontier of portfolios based on the arithmetic mean return and that of portfolios based on the geometric mean return, then it was found necessary to split the analysis into two;

(i) Analysis of the individual shares

(ii) Analysis of the portfolios constructed from (i) above

4.1.1 Stage 1: Analysis of the individual shares

The returns of each company shares were determined as the sum of capital gains and dividend yield on a weekly basis. The dividends per week in any of the years within the period of study were determined by dividing the dividends declared in that year by the total number of weeks in the year.

From this were generated a time series of weekly returns for two hundred and eighty nine weeks (the number of weeks from March 1996 to December 2001) with each week representing a row and each company representing a column.

For each column (company) the arithmetic mean, geometric mean and variance of weekly returns were computed as well as both their minimum and maximum values.

The geometric mean returns were computed using two different formulas, which produced the same results. It was necessary to use each of the formulas as justified below:

Geometric Mean Based on Formula one

Geometric mean = Arithmetic mean -0.5*variance (Equation 12)

This formula applies where and when the arithmetic mean is small compared to unit.

In this study the arithmetic mean returns were small compared to one, hence the application of the above formula.

Geometric Mean Based on Formula two

Geometric mean = $\left[\prod_{i=1}^{T}(1+r_i)\right]^{1/T}-1$ where T is the total number of periods in consideration and r_i are the returns earned in period i.

Such a formula applies when there exists some negative values (returns). This happened to be the case in this study and therefore the reason of using the formula in the analysis.

The above measures (Arithmetic mean return, geometric mean return and variance) were determined for every year considered in the period of the study.

Table 1: Average weekly returns and risk of shares listed at NSE for the period 1996 to 2001

	1996			1997			1998			1999			2000			2001			1996-2001		
	AM	VAR	GM	AM	VAR	GM	AM	VAR	GM	AM	VAR	GM	AM	VAR	GM	AM	VAR	GM	AM	VAR	GM
	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%	%
BBK	0.58	0.08	0.54	0.31	0.06	0.28	0.56	0.08	0.52	0.38	0.10	0.33	0.30	0.16	0.22	0.26	0.15	0.18	0.30	0.14	0.23
BBond	-0.28	0.04	-0.30	-0.21	0.10	-0.26	0.02	0.09	-0.02	-0.27	0.13	-0.34	-0.05	0.16	-0.13	-0.09	0.14	-0.16	-0.12	0.12	-0.18
BOC	-0.01	0.03	-0.03	-0.04	0.03	-0.06	0.13	0.03	0.12	0.10	0.06	0.07	-0.03	0.08	-0.07	-0.18	0.09	-0.22	-0.15	0.08	-0.19
BAMB	1.40	0.43	1.19	1.15	0.54	0.88	0.65	0.50	0.40	0.24	0.40	0.04	0.32	0.31	0.17	0.03	0.28	-0.11	0.22	0.30	0.07
BAT	0.73	0.13	0.67	-0.71	0.08	-0.75	0.23	0.09	0.19	0.34	0.14	0.28	0.31	0.14	0.24	0.20	0.13	0.13	0.27	0.13	0.21
UCHUMI	1.67	0.18	1.58	0.44	0.23	0.32	0.38	0.18	0.29	0.23	0.14	0.16	0.29	0.12	0.23	0.09	0.13	0.02	0.31	0.14	0.24
Total	0.62	0.39	0.42	-0.32	0.20	-0.42	-0.24	0.19	-0.34	-0.10	0.21	-0.21	-0.13	0.20	-0.23	-0.25	0.20	-0.34	-0.12	0.22	-0.23
SASINI	0.95	0.25	0.82	0.84	0.11	0.79	0.72	0.31	0.56	0.07	0.25	-0.06	0.09	0.22	-0.02	-0.21	0.21	-0.31	-0.04	0.22	-0.15
NMG	0.94	0.05	0.92	1.28	0.21	1.17	1.57	0.50	1.32	0.84	0.40	0.64	0.54	0.32	0.39	0.28	0.29	0.13	0.37	0.26	0.24
KNM	-0.64	0.11	-0.69	0.65	0.23	0.54	0.41	0.67	0.07	-0.01	0.72	-0.36	-0.06	0.71	-0.42	0.03	0.77	-0.36	-0.07	0.67	-0.40
KCB	1.66	0.29	1.51	0.29	0.25	0.17	0.09	0.19	0.00	-0.42	0.20	-0.52	-0.43	0.27	-0.57	-0.28	0.30	-0.43	0.00	0.30	-0.16
KAKUZI	0.28	0.06	0.26	0.46	0.40	0.26	0.54	0.31	0.39	0.10	0.27	-0.03	0.21	1.14	-0.36	0.04	0.96	-0.44	0.07	0.83	-0.34
GWK	0.68	0.10	0.63	0.90	0.42	0.69	0.90	0.30	0.75	0.32	0.24	0.20	0.32	0.21	0.22	0.15	0.20	0.05	0.22	0.19	0.13
EABL	0.72	0.17	0.63	0.05	0.19	-0.05	0.36	0.21	0.26	0.41	0.19	0.32	0.40	0.16	0.32	0.33	0.13	0.26	0.38	0.14	0.31
DTK	-0.22	0.29	-0.36	-0.45	0.16	-0.53	-0.17	0.12	-0.23	-0.04	0.11	-0.09	-0.32	0.13	-0.38	-0.40	0.12	-0.46	-0.37	0.14	-0.44
KPLC	3.78	2.36	2.60	1.82	0.42	1.61	1.12	0.28	0.98	0.46	0.22	0.36	0.18	0.30	0.03	-0.20	0.33	-0.36	0.37	0.62	0.06
EAPACK	0.09	0.02	0.08	-0.52	0.48	-0.76	-1.12	0.39	-1.31	-0.88	0.61	-1.18	-0.62	0.70	-0.97	-0.55	0.58	-0.84	-0.45	0.50	-0.70
SCB	0.96	0.12	0.90	0.02	0.09	-0.02	0.17	0.10	0.11	0.48	0.13	0.42	0.46	0.14	0.39	0.42	0.15	0.35	0.50	0.15	0.42
MAX	3.78	2.36	2.60	1.82	0.54	1.61	1.57	0.67	1.32	0.84	0.72	0.64	0.54	1.14	0.39	0.42	0.96	0.35	0.50	0.83	0.42
MIN	-0.64	0.02	-0.69	-0.71	0.03	-0.76	-1.12	0.03	-1.31	-0.88	0.06	-1.18	-0.62	0.08	-0.97	-0.55	0.09	-0.84	-0.45	0.08	-0.70

Index: AM = Arithmetic Mean GM = Geometric Mean VAR = Variance

From the table above, in 1996 Kenya Power and Lighting company recorded the highest arithmetic mean return (3.78%) as well as the highest geometric mean return (2.6%). Kenya National Mills recorded the lowest arithmetic mean return (-0.64%) as well as the lowest geometric mean return

(-0.70%). The company whose shares were most volatile during this period was Kenya Power and Lighting Company with a risk level of 2.36 %while those of East African Packaging had the least variation of 0.02%.

In 1997, KPLC had the highest arithmetic mean return of 1.82% as well as the highest geometric mean return of 1.61%. BAT had the lowest arithmetic mean return of (-0.71%). East Africa Packaging recorded the minimum geometric mean return of -0.76%. The highest risk level recorded was 0.54% for the shares of Bamburi Cement, while the lowest was for the shares of BOC gases (0.03%).

In 1998, both the highest arithmetic mean return (1.57%) and geometric return (1.32%)were from Nation media Group. East African Packaging on the other hand had the lowest arithmetic and Geometric mean return of -1.11% and -1.31% respectively. Kenya National mills recorded the highest risk (0.67%) while BOC gases recorded the lowest risk (0.03%).

In 1999, both the highest arithmetic mean return (0.84 %) and the geometric mean return (0.64%) were from Nation media Group respectively. The lowest arithmetic mean return (-0.88%) and lowest geometric mean return (-1.18%) were from East African Packaging. The highest risk (0.72%) was for Kenya National mills while the lowest (0.06%) was for BOC gases.

In 2000, Nation Media group recorded the highest arithmetic mean return (0.54%) while Standard Chartered Bank recorded the highest geometric mean return of (0.39%). The lowest arithmetic mean return (-0.61%) and geometric mean return (-0.97%) were for East African Packaging. Kakuzi recorded the highest risk level (1.14%) while BOC gases recorded the lowest risk level (0.08%).

In 2001, Standard Chartered Bank recorded the highest arithmetic mean return (0.42%) as well as the highest geometric mean return of (0.35%) East African Packaging recorded both the lowest arithmetic mean return (-0.55%) and geometric mean return (0.84%). Kakuzi recorded the highest risk level (0.96%) while BOC gases recorded the lowest risk level (0.09%).

For the Overall period (1996-2001):

The minimum arithmetic mean and geometric mean return were 0.46% and –0.78% respectively from the same company (East African Packaging), while the maximum arithmetic and geometric mean returns were 0.5% and 0.43% from Standard Chartered Bank.

The implication of the above is that, East African Packaging shares were the least attractive while those of standard chartered bank were the most attractive over the entire period of interest if looked at from the perspective of the weekly returns only (ignoring risk).

As opposed to this, the minimum and maximum variability of returns were from different companies; the minimum being from BOC Gases (0.09%), an indication that its share prices were relatively stable over this period. The maximum on the other hand was on Kakuzi (0.83%), an indication that there has been great fluctuation on its share price compared with all the other companies considered in this study.

Table 2: Correlation matrix (Pearson correlation coefficients between shares' return) for the period 1996 to 2001

	BBK	*BBond*	*BOC*	*BAMB*	*BAT*	*UCHUMI*	*Total*	*SASINI*	*NMG*	*KNM*	*KCB*	*KAKUZI*	*GWK*	*EABL*	*DTK*	*KPLC*	*EAPACK*	*SCB*
BBK	1																	
BBond	0.00	1																
BOC	-0.01	0.01	1															
BAMB	0.17	0.03	-0.01	1														
BAT	0.36	-0.08	-0.04	0.05	1													
UCHUMI	0.17	0.06	0.03	0.27	0.10	1												
Total	0.15	-0.06	0.11	0.21	0.37	0.13	1											
SASINI	0.05	-0.04	-0.02	0.12	0.01	0.03	0.07	1										
NMG	0.06	0.05	0.06	0.03	0.02	0.01	0.04	0.09	1									
KNM	0.09	0.17	0.06	0.05	0.00	-0.04	0.06	0.03	0.06	1								
KCB	0.24	0.07	0.04	0.18	0.05	0.16	0.05	0.10	0.09	0.00	1							
KAKUZI	-0.01	0.02	-0.02	0.02	-0.05	-0.01	0.01	0.09	0.08	0.01	0.11	1						
GWK	-0.02	0.09	-0.04	-0.03	-0.03	0.03	0.03	0.08	0.06	0.03	0.00	0.10	1					
EABL	-0.02	0.09	0.00	0.06	0.13	0.12	0.13	-0.06	-0.04	-0.15	0.07	-0.01	-0.06	1				
DTK	0.14	0.02	-0.03	0.07	0.15	0.09	0.22	0.13	0.06	0.06	-0.03	-0.11	0.04	0.07	1			
KPLC	0.26	0.01	0.01	0.31	0.24	0.26	0.28	0.15	0.02	-0.02	0.07	0.03	-0.03	0.04	0.21	1		
EAPACK	-0.11	-0.04	-0.07	0.08	-0.08	-0.02	0.03	-0.08	-0.05	0.02	-0.09	-0.01	-0.01	-0.17	0.06	0.02	1	
SCB	0.42	-0.11	-0.04	0.22	0.32	0.13	0.15	0.07	0.09	-0.02	0.22	0.07	-0.02	0.12	0.14	0.21	-0.09	1

The companies whose shares were least correlated were East African Breweries and Kenya National Mills with a correlation of -0.15. This is an indication that the shares of both companies move in opposite direction and therefore it would be prudent for an investor in common stocks to consider a combination of this two companies' shares instead of buying shares from only one of them. This is so because such a combination yields less risk than a mere weighted average of the individual shares' risk. A portfolio composed of these two companies' shares would have the lowest risk possible compared to any other combination.

On the other hand the shares of Standard Chartered Bank and Barclays Bank had the highest correlation (0.42). This would mean that the two companies' shares move in the same direction, and therefore too risky for an investor to put their money in both, as a portfolio composed of the two would still have a high risk.

Table 3: Covariance matrix of weekly returns of shares listed at NSE for the period 1996 to 2001

14.91	0.05	-0.16	3.68	5.06	2.53	2.88	0.98	1.25	3.04	5.25	-0.31	-0.36	-0.31	2.09	8.11	-2.99	6.39
0.05	12.85	0.13	0.61	-1.10	0.76	-1.00	-0.65	0.90	5.11	1.40	0.82	1.36	1.25	0.27	0.24	-1.05	-1.56
-0.16	0.13	8.63	-0.12	-0.44	0.35	1.62	-0.25	0.87	1.36	0.69	-0.51	-0.47	0.04	-0.34	0.19	-1.57	-0.51
3.68	0.61	-0.12	31.63	1.01	5.76	5.69	3.17	1.00	2.25	5.68	1.01	-0.72	1.36	1.45	13.98	3.34	4.85
5.06	-1.10	-0.44	1.01	13.53	1.45	6.50	0.20	0.30	-0.03	1.03	-1.56	-0.47	1.85	2.16	7.01	-2.01	4.66
2.53	0.76	0.35	5.76	1.45	14.38	2.44	0.56	0.15	-1.36	3.43	-0.40	0.53	1.79	1.34	7.79	-0.55	2.01
2.88	-1.00	1.62	5.69	6.50	2.44	23.40	1.51	0.90	2.50	1.28	0.54	0.63	2.44	4.12	11.03	1.09	2.89
0.98	-0.65	-0.25	3.17	0.20	0.56	1.51	22.70	2.27	1.12	2.62	4.16	1.58	-1.01	2.39	5.78	-2.74	1.38
1.25	0.90	0.87	1.00	0.30	0.15	0.90	2.27	27.14	2.68	2.61	3.94	1.33	-0.73	1.26	1.00	-1.91	1.91
3.04	5.11	1.36	2.25	-0.03	-1.36	2.50	1.12	2.68	70.46	0.17	0.97	1.28	-4.76	1.95	-1.42	1.10	-0.74
5.25	1.40	0.69	5.68	1.03	3.43	1.28	2.62	2.61	0.17	31.78	5.93	0.00	1.44	-0.55	3.10	-3.88	4.90
-0.31	0.82	-0.51	1.01	-1.56	-0.40	0.54	4.16	3.94	0.97	5.93	86.82	4.14	-0.25	-3.89	1.91	-0.43	2.72
-0.36	1.36	-0.47	-0.72	-0.47	0.53	0.63	1.58	1.33	1.28	0.00	4.14	19.44	-0.97	0.76	-1.00	-0.23	-0.31
-0.31	1.25	0.04	1.36	1.85	1.79	2.44	-1.01	-0.73	-4.76	1.44	-0.25	-0.97	14.42	0.97	1.24	-4.66	1.86
2.09	0.27	-0.34	1.45	2.16	1.34	4.12	2.39	1.26	1.95	-0.55	-3.89	0.76	0.97	15.14	6.45	1.62	2.09
8.11	0.24	0.19	13.98	7.01	7.79	11.03	5.78	1.00	-1.42	3.10	1.91	-1.00	1.24	6.45	64.72	1.18	6.60
-2.99	-1.05	-1.57	3.34	-2.01	-0.55	1.09	-2.74	-1.91	1.10	-3.88	-0.43	-0.23	-4.66	1.62	1.18	52.58	-2.68
6.39	-1.56	-0.51	4.85	4.66	2.01	2.89	1.38	1.91	-0.74	4.90	2.72	-0.31	1.86	2.09	6.60	-2.68	15.55

The above covariances (later used as inputs to portfolio construction), are the measures of the co movement between shares' returns. They were determined as products of both the shares' risks (standard deviations) and the correlation coefficients determined in table 2 above. The lower this values are, the less the risk of the portfolios is.

Risk – Return Relationship:

The hypothesized relationship is that rational investors expect to be compensated for additional risk assumed (taken). Our findings show that there exists a statistically insignificant negative Pearson correlation coefficient of –0.13 between arithmetic mean of returns and the variance of the returns. This could mean that the arithmetic mean return increases as the risk level decreases by a magnitude of only 0.13. These findings contradict the Jensen's inequality which points out that the arithmetic mean return as an increasing function of risk (variance or standard deviation of returns), Jensen (1968).

On the other hand the association between geometric mean return and variance was negative, with a magnitude of 0.47.Just as was the case with the arithmetic mean return, it is not advisable, to a large extent, to associate the risk level with the returns. This so because, the Pearson correlation above between the geometric mean and variance of returns is statistically insignificant. This argument contradicts CAPM theory that investors should be proportionally compensated for risk taken. That is, the investor who takes a higher risk should be rewarded more than who takes less risk. It is worth pointing out that, this finding agrees with the Jensen's inequality.

It was also found that there is a high Pearson correlation between the arithmetic mean return and geometric mean return with a magnitude of 0.94. The implication of this is that, the two average measures of return performance are closely related as their association is found to be statistically significant.

A test of the hypothesis using a two tailed t-test at the 5% level of significance failed to reject the null hypothesis. It was concluded that the arithmetic mean return and geometric mean return are not significantly different since the computed t value of 0.15 was found to fall within the acceptance region determined by the critical $t_{16,0.025} = 2.12$. The implication of this is that we are 95% confident that the difference between the two means is not statistically significant for this market.

The probability is only 0.05 that the two means are significantly different. Therefore one can use either measure in measuring the average performance of assets quite comfortably, at least in this market (NSE).

4.1.2 Stage 2: Analysis of constructed portfolios and Efficient Frontier

Introduction:

A portfolio is a group or collection of assets. Investors consider putting their wealth (funds) into different assets, essentially to minimize risk for the same level of return. This is usually achievable by allocating different proportions of the total wealth to different assets depending on both the risk-return combination and correlation of the assets. It is for this reason that, this analysis was done so as to determine which combination of assets (shares) would give the minimum risk for the same level of return. Such a combination is what investors are advised to go for, instead of putting all their wealth in one asset, which gives the same return, probably with a higher risk.

Table 4: Portfolios of shares listed at NSE for the period 1996 to 2001

	Arithmetic		Geometric	
Portfolios	Risk	Return	Risk	Return
1	1.30	0.00	1.29	0.00
2	1.30	0.01	1.32	0.05
3	1.28	0.05	1.40	0.10
4	1.30	0.10	1.45	0.13
5	1.31	0.13	1.51	0.15
6	1.34	0.15	1.58	0.18
7	1.38	0.18	1.65	0.20
8	1.43	0.20	1.74	0.23
9	1.49	0.23	1.83	0.25
10	1.56	0.25	1.93	0.28
11	1.63	0.28	2.08	0.30
12	1.72	0.30	2.29	0.33
13	1.80	0.33	2.56	0.35
14	1.91	0.35	2.91	0.38
15	2.03	0.38	3.38	0.40
16	2.22	0.40	3.96	0.43
17	2.48	0.43	4.03	0.45
18	2.81	0.45		
19	3.29	0.48		
20	3.94	0.50		

Twenty portfolios were constructed on the basis of the arithmetic mean while seventeen portfolios were constructed on the basis of the geometric mean, with the objective of minimizing risk for a given level of return. Specifically, the portfolios' returns were set at fixed levels (target returns) and their corresponding risk levels and proportion invested in each share determined.

The form of the minimization problem was:

$$\text{Minimize } \sigma(R_p) = \left[\Sigma\, x_i^2 \sigma(Ri)^2 + \Sigma\Sigma\, x_i x_j \operatorname{cov}(R_i, R_j)\right]^{1/2} \quad \text{(Equation 13)}$$

Subject to $E(R_p)$ = a constant (Target return)

Where;

$\sigma(R_p)$ = the portfolio risk,

$\operatorname{cov}(R_i,R_j)$ = the covariance between returns of share i and share j,

R_i = the returns of share i

$E(R_p)$ = the expected return of a given portfolio.

And $\Sigma x_i = 1.0, x_i > 0$ for all i.

where x_i is the weight (proportion of total wealth invested in the i^{th} share).

Table 5: Portfolio Returns, Risks And Shares' Weightings Based On Arithmetic Mean

Risk	1.28	1.30	1.31	1.34	1.38	1.43	1.49	1.56	1.63	1.72	1.80	1.91	2.03	2.22	2.48	2.81	3.29	3.94
Decision Variables																		
BBK	0.05	0.06	0.06	0.06	0.06	0.07	0.07	0.07	0.07	0.08	0.08	0.07	0.05	0.01	0.00	0.00	0.00	0.00
BBond	0.12	0.10	0.10	0.09	0.07	0.06	0.05	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BOC	0.21	0.19	0.18	0.16	0.14	0.12	0.10	0.08	0.06	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BAMB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BAT	0.08	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.04	0.00	0.00	0.00	0.00	0.00
UCHM	0.05	0.07	0.07	0.08	0.09	0.10	0.11	0.11	0.12	0.13	0.14	0.15	0.14	0.13	0.09	0.01	0.00	0.00
TOTAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SASINI	0.07	0.06	0.06	0.06	0.05	0.04	0.04	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NMG	0.03	0.04	0.05	0.06	0.06	0.07	0.08	0.09	0.09	0.10	0.11	0.12	0.13	0.14	0.14	0.13	0.05	0.00
KNM	0.01	0.01	0.01	0.01	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00
FIRE	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KCB	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KAKZ	0.08	0.09	0.09	0.10	0.10	0.11	0.11	0.12	0.12	0.13	0.14	0.14	0.11	0.08	0.02	0.00	0.00	0.00
GWK	0.11	0.13	0.14	0.15	0.16	0.17	0.18	0.19	0.20	0.22	0.23	0.24	0.25	0.26	0.27	0.26	0.15	0.00
EABL	0.06	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DTK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00
KPLC	0.06	0.06	0.06	0.05	0.04	0.04	0.03	0.03	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EAPACK	0.04	0.06	0.07	0.09	0.10	0.11	0.12	0.13	0.15	0.16	0.17	0.20	0.28	0.37	0.47	0.60	0.80	1.00
Target return	0.05	0.10	0.13	0.15	0.18	0.20	0.23	0.25	0.28	0.30	0.33	0.35	0.38	0.40	0.43	0.45	0.48	0.50

Table 6: Portfolio Returns, Risks And Shares' Weightings Based On Geometric Mean

Risk	1.29	1.32	1.40	1.45	1.51	1.58	1.65	1.74	1.83	1.93	2.08	2.29	2.56	2.91	3.38	3.96	4.03	2.56
Decision Variables																		
BBK	0.06	0.06	0.07	0.07	0.07	0.08	0.08	0.08	0.08	0.08	0.05	0.01	0.00	0.00	0.00	0.00	0.00	0.00
BBond	0.11	0.10	0.08	0.07	0.06	0.05	0.04	0.02	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BOC	0.20	0.18	0.15	0.14	0.12	0.10	0.09	0.07	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BAMB	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
BAT	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.05	0.00	0.00	0.00	0.00	0.00	0.00	0.00
UCHM	0.06	0.08	0.09	0.10	0.11	0.12	0.13	0.14	0.14	0.15	0.14	0.14	0.11	0.03	0.00	0.00	0.00	0.11
TOTAL	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
SASINI	0.06	0.06	0.05	0.04	0.03	0.02	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NMG	0.04	0.05	0.06	0.07	0.07	0.08	0.09	0.09	0.10	0.11	0.10	0.10	0.09	0.04	0.00	0.00	0.00	0.09
KNM	0.01	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
FIRE	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KCB	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KAKZ	0.08	0.09	0.10	0.11	0.12	0.12	0.13	0.13	0.14	0.13	0.10	0.06	0.00	0.00	0.00	0.00	0.00	0.00
GWK	0.12	0.14	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.24	0.26	0.28	0.30	0.29	0.18	0.00	0.00	0.30
EABL	0.03	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
DTK	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
KPLC	0.06	0.05	0.04	0.03	0.02	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
EAPACK	0.06	0.08	0.10	0.11	0.13	0.14	0.15	0.16	0.18	0.20	0.30	0.40	0.50	0.64	0.82	1.00	1.02	0.50
Target return	0.00	0.05	0.10	0.13	0.15	0.18	0.20	0.23	0.25	0.28	0.30	0.33	0.35	0.38	0.40	0.43	0.45	0.50

Referring to tables 5 and 6 above, it was confirmed that in all cases (all the constructed portfolios), the proportions summed to one. This was necessary to ensure that, the results obtained were accurate enough (satisfy the condition above) for their reliability, probably in the future for further studies. In both cases (arithmetic and geometric) the portfolio risk went on increasing for every higher level of return set, with the proportions of wealth in different shares changing. In the first portfolios all shares are included with those of some companies getting eliminated in the construction of portfolio after portfolio, and eventually only one company is assigned all the wealth. It was worth noting that for every portfolio the risk was higher in the geometric mean case than the arithmetic mean case.

It was also noted that, every share included in the portfolios based on the geometric mean was also present in the portfolios based on the arithmetic mean. This can be interpreted to mean that there is no shift in the shares that constitute portfolios constructed based on arithmetic mean and those based on the geometric mean. In the case where a share was eliminated (had zero proportion), in a portfolio based on the geometric mean, the same share happened to have an insignificantly small proportion (nearly zero), in a similar portfolio (having the same target return) based on the arithmetic mean.

This interprets to the market of shares (Nairobi Stock Exchange) as having no significant difference between the two measures of average performance (the arithmetic mean and geometric mean).

With the predetermined level of return set at a higher level, the accompanying risk was equally high, with some shares being eliminated and those which remained in the portfolios' composition having more weighting compared to the case where more or all shares were included in the portfolios. Setting the target return beyond 0.45% was not possible because the total proportion of the wealth invested would exceed 1(100%). Such a situation is only possible with borrowing, which was not a consideration in this study.

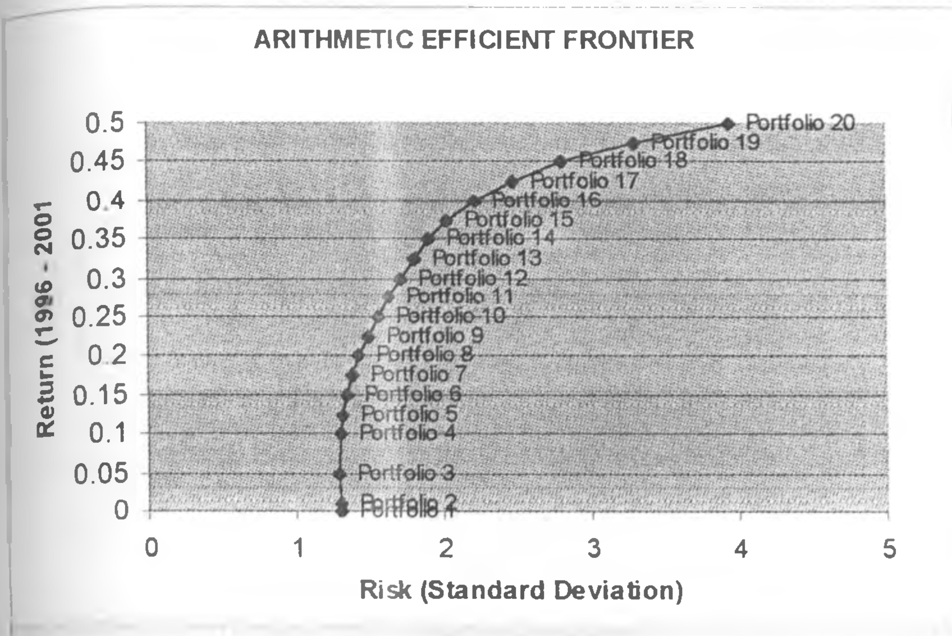


Figure 1: Efficient Frontier of portfolios of shares listed at NSE (based on arithmetic mean)

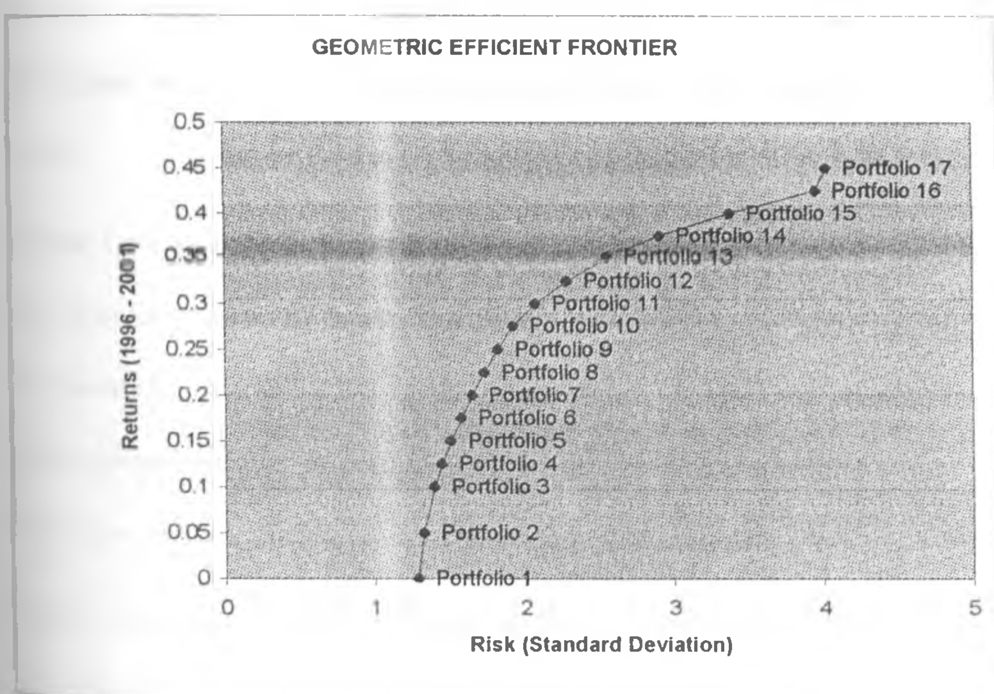


Figure 2: Efficient Frontier of portfolios of shares listed at NSE (based on geometric mean)

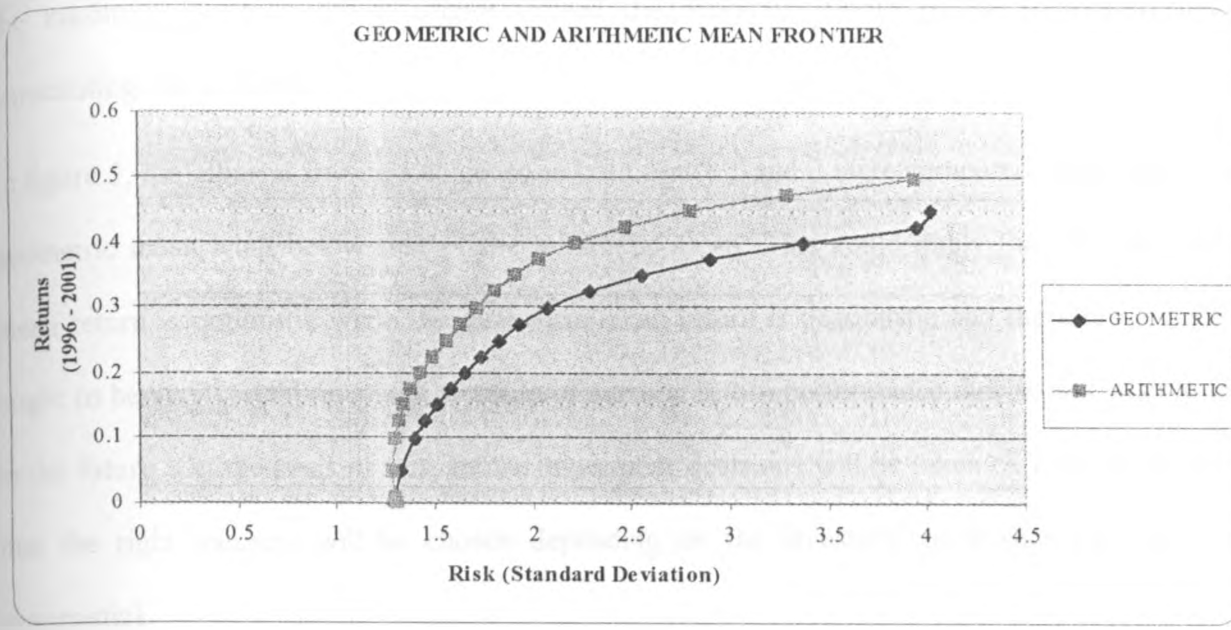


Figure 3: Geometric and Arithmetic Mean Based Efficient Frontiers of portfolios of shares listed at NSE Compared

Using the two sets of portfolios constructed (table 2), arithmetic and geometric mean efficient frontiers were constructed. The efficient set of portfolios consists of those portfolios that offer the highest return for each and every level of risk, or the lowest risk for each and every level of return.

Figure 1 above is the efficient frontier of portfolios constructed on the basis of arithmetic mean. This frontier consists of twenty portfolios, the minimum portfolio having zero target return and the maximum having 0.45% as the target return. It was not possible to construct a portfolio whose target return is more than 0.45% because such a portfolio would have a total wealth of more than 100%, violating the set condition in this analysis.

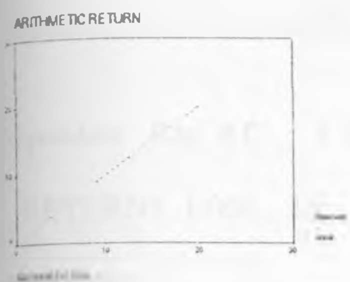
Figure2 explains the efficient frontier of portfolios constructed on the basis of arithmetic mean. This frontier consists of seventeen portfolios; the minimum portfolio having zero target return and the maximum having 0.5%. The reason of setting a maximum target return of 0.5% is that the maximum portfolio return cannot exceed the maximum return of the individual shares constituting that portfolio.

In figure 3, the efficient frontiers achieved in both figure 1 and 2 were compared, with that of the geometric mean lying below that of the arithmetic mean. This could imply that, the arithmetic mean return is optimistic while the geometric mean return is pessimistic and therefore investors ought to be very careful on which measure of average return performance they would wish to use in the future. On the basis of this, future investment decisions will be taken care of, in the sense that the right measure will be chosen depending on the investors' preference (optimistic or pessimistic).

Curve Estimation:

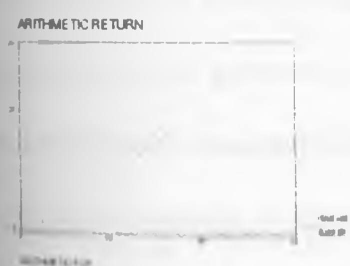
Independent: RISK1 (Arithmetic return linear function)

Dependent	Rsq	d.f.	F	Sigf	b0	b1
RETURN1	1.000	18	.	.	0000	1.0000



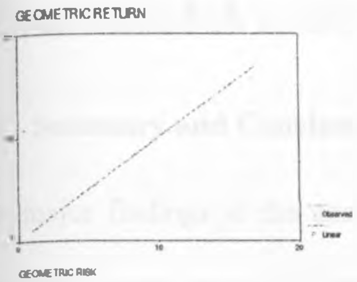
Independent: RISK1 (Arithmetic return quadratic function)

Dependent	Rsq	d.f.	F	Sigf	b0	b1	b2
RETURN1	1.000	18	.	.	.0000	1.0000	



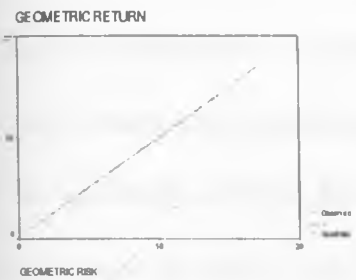
Independent: RISK2 (Geometric return linear function)

Dependent	Rsq	d.f.	F	Sigf	b0	b1
RETURN2	1.000	15	.	.	.0000	1.0000



Independent: RISK2 (Geometric return quadratic fit)

Dependent	Rsq	d.f.	F	Sigf	b0	b1	b2
RETURN2	1.000	15	.	.	.0000	1.0000	



Using regression analysis, curve fitting (linear and quadratic) was done for both the arithmetic mean return and geometric mean return, as functions of risk. The resulting linear equations showed that the observed values and the actual values of risk and return fall on the same straight line. Such equations were interpreted to be the best curve estimates, for both arithmetic and geometric mean return as functions of risk. The form of the equation is y = x where y is the returns and x represents risk, which passes through the origin. The quadratic fits, on the other hand turned out to be linear; exactly the same as the linear curve estimates, an indication that the risk- return relationship cannot have a quadratic fit. This could be a strong confirmation that the risk- return relationship is actually linear, at least, as far as the common stocks listed at Nairobi stock exchange are concerned.

CHAPTER FIVE: SUMMARY AND CONCLUSION

5.1 Summary and Conclusion

The major findings in the analysis of this research showed that the arithmetic mean return and geometric mean return for the shares listed at the Nairobi stock exchange are not statistically significantly different, with their association being statistically significant (very strong). Worth noting was the finding that there was an insignificant difference in the respective proportion of weights in the shares constituting the portfolios in both the geometric mean and arithmetic mean cases.

A major contradiction of earlier findings discussed in the literature review arose with the geometric mean based portfolios having a higher risk than the arithmetic mean based portfolios, yet the geometric efficient frontier lies below the arithmetic efficient frontier. It was also noted that there was no shift in shares that constitute portfolios constructed based on arithmetic mean and those based on the geometric mean. We can therefore conclude, though not strongly, that the investment strategy in choosing assets to include in a portfolio using the geometric mean is not significantly different from the one used in choosing assets to include in a portfolio using arithmetic mean if the target return is the same.

On the basis of the above findings, the researcher leaves the discussions in this paper open to further scrutiny instead of committing the findings to a concrete conclusion. Therefore, as a result of this, investors ought to be very careful on the measure of average return they would wish to use in future depending on their risk preferences. It is worth commenting that the risk of the market will depend on the measure of average return used and that the optimistic investor may find the arithmetic mean comfortable to use in both the single period and multi-period cases.

5.2 Limitations of the Study

The study was based on assumptions and findings of a theory that is still subject to debate As such, the researcher had to leave the recommendations open to debate as some of the underlying assumptions are still subject to being relaxed, a case which is bound to change the conceptual framework of the theory, and probably just confirm the existing theory (CAPM theory).

Due to time and money factor, the researcher concentrated only on a few companies and therefore it is in light of these that, the following suggestions for further research were made

5.3 Suggestions for Further Research

1. Comparison between arithmetic mean efficient frontier and geometric mean efficient frontier can be done considering a longer period of study, if possible more than ten years, to test the same theory.

2. Further research can be carried out using other types of assets like real assets and bonds and by extension all classes of assets to arrive at more concrete findings

3. Further research can be done considering a bigger sample size and if possible all the listed companies because such a study may produce more reliable results.

APPENDIX i

COMPANIES LISTED ON THE NAIROBI STOCK EXCHANGE

Agricultural Sector

2 Brooke Bond Ltd. Ord. 10.00

3 Kakuzi Ltd. Ord. 5.00

4 Rea Vipingo Plantations Ltd. Ord. 5.00

5 Sasini Tea & Coffee Ltd. Ord. 5.00

6 Williamson Tea Kenya Ltd. Ord. 5.00

7. Kapchorua Tea Com. Ltd. Ord. 5.00

8. Kenya Orchards Ltd. Ord. 5.00

9. Limuru Tea Com. Ltd. 20.00

10. Eaagads Ltd. Ord. 1.25

Commercial and Sector

11. African Lakes Corporation PLC Ord. 5.00

12. Car & General (K) Ltd. Ord. 5.00

13. Express Ltd. Ord. 5.00

14. CMC Holding Ltd. Ord. 5.00

15. Hutching Biemer Ltd. Ord. 5.00

16. Kenya Airways Ltd. Ord. 5.00

17. Marshalls (E.A) Ltd. Ord 5.00

18. Standard Newspapers Group Ltd. Ord. 5.00

19. Nation Media Group Ltd. Ord. 5.00

20. Tourism Promotion Services Ltd. Ord. 5.00 (Serena)

21. Uchumi Supermarket Ltd. Ord. 5.00

22. A. Baumann & Co. Ltd. Ord. 5.00

Finance and Investment Sector

23. Barclays Bank Ltd. Ord. 10.00

24. C.F.C Bank Ltd. Ord. 5.00

25. Diamond Trust Bank Kenya Ltd. Ord. 4.00

26. Housing Finance Co. Ltd. Ord. 5.00

27. ICDC Investment Co. Ltd Ord. 5.00

28. Jubilee Insurance Co. Ltd. Ord. 5.00

29. Kenya Commercial Bank Ltd. Ord. 10.00

30. National Bank of Kenya Ltd. Ord. 5.00

31. NIC Bank Ltd. Ord. 5.00

32. Pan Africa Insurance Ltd. Ord. 5.00

33. Standard Chartered Bank Ltd. Ord. 5.00

34. City Trust Ltd. Ord. 5.00

Industrial and Allied Sector

35. Athi River Mining Ltd. Ord. 5.00

36. B.O.C. Kenya Ltd. Ord. 5.00

37. Bamburi Cement Ltd. Ord. 5.00

38. British American Tobacco Kenya Co. Ltd. Ord. 10.00

39. Carbacid Investment Ltd. Ord. 5.00

40. Crown Berger Ltd Ord. 5.00

41. Dunlop Kenya Ord. 5.00

42. E.A. Cables Ltd. Ord. 5.00

43. E.A. Portland Cement Ltd. Ord. 5.00

44. East Africa Breweries Ltd. Ord. 10.00

45. Firestone East Africa Ltd. Ord. 5.00

46. Kenya National Mills Ltd. Ord. 5.00

47. Kenya Oil Co. Ltd. Ord. 5.00

48. Mumias Sugar Co. Ltd. Ord 2.00

49. Kenya Power and Lighting Co. Ltd. Ord. 20.00

50. Total Kenya Co. Ltd. Ord. 5.00

51. Unga Group Ltd. Ord. 5.00

52. E.A. Packaging Ltd. Ord. 5.00

Source: NSE

APPENDIX ii

THE COMPANIES CONSIDERED IN THE STUDY

1. Brooke Bond
2. George Williamson Tea
3. Kakuzi Ltd
4. Sasini
5. Uchumi Supermarkets Ltd
6. Nation Media Group
7. Barclays Bank of Kenya
8. Diamond Trust
9. Kenya Commercial Bank
10. Standard Chartered Bank
11. Bamburi Cement
12. British American Tobacco Kenya Ltd.
13. BOC Gases Ltd
14. East African Packaging Ltd
15. East African Breweries Ltd
16. Kenya National Mills
17. Kenya Power & Lighting Company
18. Total Kenya Ltd

APPENDIX iii

Weekly returns (percentage) of shares listed at NSE for the period 1996 to 2001

Week	BBK	BBond	BOC	BAMB	BAT	UCHUMI	Total	SASINI	NMG	KNM	KCB	KAKUZI	GWK	EABL	DTK	KPLC	EAPACK	SCB
04.03.1996	0	-0.01	0	-0.01	0	-0.01	0	0	-0.06	-0.04	0.06	-0.05	-0.09	0.07	0	-0.03	0	-0.03
11.03.1996	0.02	0.02	0	0	0	-0.01	-0.02	0.02	0.04	0	-0.11	-0.01	-0.02	0	-0.02	0	0	-0.03
18.03.1996	0.07	0	0	0.12	0.02	0.02	-0.01	0.15	0.05	0.02	0.1	0.03	-0.01	-0.06	0	0.02	0	0.12
25.03.1996	-0.02	0.01	0	0.08	0	0.01	0.01	0.1	0	0.02	0.02	0	0	0.01	0.01	-0.02	0	0
01.04.1996	-0.01	0.01	0	-0.05	0	0	0.06	-0.02	0.01	0.03	0	0.04	0	0.01	0.02	-0.04	0	0.01
08.04.1996	0.01	0	-0.04	-0.02	0	0	0.01	-0.01	0	-0.04	0.03	0.06	0.12	0.02	0	0.07	-0.01	0.01
15.04.1996	-0.01	0	0	0.01	0	-0.01	0.08	0.02	0.01	-0.02	-0.03	0	0.01	0	-0.01	-0.02	0	0
22.04.1996	0	0	0	0.08	0.01	0.02	-0.02	-0.01	0	0.01	-0.04	0.02	0	0	-0.03	0.03	-0.01	0.03
29.04.1996	0.01	-0.01	-0.01	0	0.02	-0.02	-0.03	-0.03	0.02	-0.02	-0.08	0.01	0.04	0.01	0.04	0.03	-0.01	0.04
06.05.1996	0	0.02	-0.02	0.02	-0.01	0.02	-0.04	-0.03	0.01	0	0.07	0.03	0	0.02	0.02	0.01	0.02	0.02
13.05.1996	-0.01	0	0	0	0.04	0	-0.06	-0.03	0.08	0	0.03	0	0	0.1	0.01	0.02	0	-0.01
20.05.1996	-0.02	0	0.03	0.03	-0.02	0.08	0.01	0	0.01	0	0	0.02	0.09	-0.01	0.03	0.06	0.01	-0.02
27.05.1996	-0.01	0	-0.06	-0.03	0	0.03	0.01	0	0.02	0	0	-0.02	0.03	0	0	0.05	-0.01	0.01
03.06.1996	0.01	0	-0.02	0	0	0.01	-0.01	0.04	0.04	0.02	0.01	-0.11	-0.02	0.03	0.02	0.04	0.02	0.02
10.06.1996	-0.01	0	-0.02	-0.02	0	0	-0.01	0	0	0.01	-0.01	0	0.03	-0.03	-0.02	0.01	-0.01	-0.03
17.06.1996	0.01	0	-0.01	0	0	-0.01	-0.01	0	0.03	0.04	0.01	0	0	0.05	-0.01	0.04	0.02	-0.01
24.06.1996	-0.01	0	0	-0.04	0.01	-0.02	-0.02	0	-0.02	0	0.06	0	0.02	-0.02	0	0.01	0	-0.01
01.07.1996	0.03	0	0	0.01	0	0.01	-0.02	-0.12	-0.02	-0.02	0.02	0.01	-0.06	-0.02	-0.01	0	0.02	0.01
08.07.1996	0	0	0	0.01	0	0.05	0	0.05	0.01	0	-0.05	0	0.03	0	-0.02	-0.01	0	0.02
15.07.1996	-0.02	-0.03	0.01	-0.01	-0.01	-0.01	-0.04	0	0.02	-0.02	-0.02	0	0.02	-0.02	-0.2	-0.01	-0.02	-0.01
22.07.1996	0.01	0.02	-0.01	0	-0.01	0	-0.01	-0.02	0.05	-0.01	0.01	0.02	0	-0.01	0.04	0.03	0	0.01
29.07.1996	0.04	0	-0.01	-0.07	-0.04	0.01	0.02	0.03	0.01	-0.04	-0.01	0.01	-0.01	-0.07	0.01	0.08	-0.01	0.05
05.08.1996	-0.02	0	0.04	0.04	-0.05	0.02	-0.02	0	0	0.08	-0.02	0	0.01	0.09	0.02	0.03	-0.01	-0.02
12.08.1996	-0.02	0.01	0	0.01	-0.03	0.02	0.01	-0.04	0	0.01	0.09	-0.01	0	-0.08	-0.04	-0.05	0	0.02
19.08.1996	0.01	-0.01	-0.03	-0.01	0.02	0.19	-0.01	0.04	0	0	0.03	0.01	0.04	-0.01	-0.01	0.09	0.01	0.02
26.08.1996	0	0	0	0	0	0	-0.01	0.02	0	0.01	-0.05	0	0.01	0.03	-0.01	-0.04	0.02	0.01
02.09.1996	-0.02	0	0.03	-0.02	0.01	0.06	0	0.02	-0.01	0	0.01	0.01	0	0.05	-0.03	0.02	0.01	0
09.09.1996	-0.01	-0.04	0	0.02	0	0.01	-0.01	-0.01	0.02	-0.04	0.02	0	0	0.01	-0.01	0.05	0	0.01
16.09.1996	0.01	0	0	-0.02	0.01	-0.08	-0.01	0.02	-0.02	-0.04	0	0.01	0	0	-0.01	0.02	0	0.01
23.09.1996	0.01	0	0	0.01	0	-0.01	-0.09	0.04	0.02	-0.02	0.03	-0.01	-0.01	-0.02	-0.02	0.02	-0.03	0.01
30.09.1996	0	0.04	0.02	0	0.01	-0.01	0.01	0.02	-0.01	0	0.05	0.01	0.03	0.04	0.05	0.04	0	0
07.10.1996	0.01	0	-0.01	-0.01	-0.01	0	0	0.02	0	0	0.08	0	-0.02	0.03	-0.05	0	0	0.01
14.10.1996	0.01	0.01	0	0.04	0.01	0	0.01	0.03	0.01	0	0.2	0	0	-0.04	0.01	0.04	0	0
21.10.1996	0	0	0	0.02	0	0.05	0.02	0.02	0.01	0	0.05	0.01	-0.01	0.08	-0.05	-0.01	0	0.01
28.10.1996	0.01	-0.05	-0.01	0	0.01	0.09	0.01	-0.01	-0.01	-0.02	-0.08	-0.01	0.01	-0.07	0	0	0	0.02
04.11.1996	0.01	0	0	-0.01	0	0.06	0.01	-0.03	0.01	0.02	-0.02	0	-0.01	-0.01	0	0.01	0	0
11.11.1996	0.02	0.01	0	0.03	0	0.01	0.02	0.1	0	-0.01	0.08	0	0	0.02	-0.03	0.17	-0.03	0.02
18.11.1996	0.06	-0.08	0.02	0.09	0.04	0.02	0.02	-0.01	0.01	-0.02	0.07	0	0.01	-0.01	0.01	0.02	0	0.07
25.11.1996	0.14	-0.05	0	0.35	0.2	0.11	0.35	0.11	0.02	-0.01	0.02	0.01	0.04	0.05	0.18	0.96	0.05	0.14
02.12.1996	-0.04	-0.01	0.04	-0.03	0.06	0.01	0.07	0.06	0.01	-0.15	0.05	0.02	0	0	0.13	-0.16	0	-0.06

09.12.1996	-0.01	0.01	0.02	-0.07	0	-0.03	-0.05	-0.13	-0.01	-0.02	0	0	0	0.06	-0.11	-0.03	0	-0.03
16.12.1996	0.01	0.01	0.02	0	-0.03	-0.07	-0.1	0.11	-0.04	0.01	0.02	0.01	0	-0.04	0	0.22	0	0.04
23.12.1996	0.03	0	0.01	0.06	-0.05	0.11	-0.05	0.01	0	-0.05	0.02	0	0.01	0	-0.06	0.23	0	-0.01
30.12.1996	0.01	0	0.03	0.31	-0.18	0.07	-0.02	0	0.03	-0.04	0.04	0.01	0	0.09	-0.01	-0.06	-0.01	0.02
06.01.1997	-0.05	0.01	0	-0.06	-0.01	-0.01	-0.02	0.02	-0.01	0.07	0.04	0.01	0	0.11	0.09	-0.01	0	-0.04
13.01.1997	-0.02	0	0.01	0.08	0.03	-0.02	-0.03	0	0	-0.01	0.05	0.01	0	-0.06	-0.18	0	0	-0.13
20.01.1997	0.01	-0.05	-0.04	-0.01	0	-0.09	-0.17	0.07	0.01	0	-0.07	-0.02	0	-0.03	0.02	-0.01	-0.02	-0.01
27.01.1997	-0.01	-0.05	0	0.09	0	-0.05	0	-0.05	0.01	0.09	0	0	0	0.01	0	-0.01	0	0
03.02.1997	-0.08	-0.04	-0.01	0.01	-0.01	0	0.04	0	-0.01	-0.02	-0.01	0	0	0.06	-0.1	-0.02	0	0
10.02.1997	-0.01	-0.07	0.01	-0.05	0	0.05	0.02	0.02	0.1	0.01	0.02	0.01	-0.03	-0.04	0.07	0.04	0	-0.03
17.02.1997	0	-0.01	0	0.02	0	0.01	-0.01	-0.01	0.05	0.01	0	-0.01	-0.01	0.02	0.03	0.01	0	-0.02
24.02.1997	0.01	0.03	-0.03	0.01	0	0	-0.01	0.04	0.17	-0.04	-0.02	0	0	-0.02	0	0	0	-0.02
03.03.1997	0.03	0	-0.01	0.01	0	0	0	-0.03	0.04	-0.01	-0.07	0	0	0	0.04	0.02	0	0.01
10.03.1997	0.06	0.02	0	0.02	-0.01	0.07	0.01	-0.01	0.04	-0.03	0.03	0.01	0.01	0.03	-0.02	0	-0.23	0.03
17.03.1997	0.05	-0.01	0.01	0.02	0.01	0.03	0.01	0.05	0.03	0.03	0.05	0	-0.01	0	0.02	0.05	0.04	0.01
24.03.1997	0	-0.01	0.01	-0.04	-0.01	0	0.01	-0.04	0	-0.02	0.01	0.01	0	-0.02	0	0.05	-0.01	0.02
31.03.1997	-0.02	0.01	0	0	0.03	0.01	0.06	0	0.06	0.02	0.01	0	-0.01	0	0.02	0.15	0.37	0
07.04.1997	0.01	0.01	0	-0.01	0.01	-0.03	0.01	0	-0.04	0	0.01	0.02	0	0.03	0.03	0.11	-0.08	0
14.04.1997	-0.01	-0.04	0.01	0	0	0	0	0.02	-0.1	0.05	0.03	-0.08	0.01	-0.03	-0.01	-0.01	0.01	0.01
21.04.1997	0	0.04	0.01	0	-0.03	0	-0.06	0.01	0.1	0.02	0.04	0.12	0	0.01	-0.02	-0.01	0	0
28.04.1997	0	-0.02	0.07	0.01	0.02	0	-0.03	0.04	0.04	0.16	0.13	-0.01	0	-0.02	-0.01	0.03	-0.03	0.01
05.05.1997	0	-0.04	0	0	-0.01	-0.03	0.01	0	-0.01	0.11	0.06	0.01	0.01	0.03	0.01	-0.02	0	0
12.05.1997	0	0.02	0	0	0	-0.02	0	0.04	0.01	-0.04	0	-0.06	0.01	-0.04	0	0.02	0	0.01
19.05.1997	0	0.02	-0.02	0.04	0	0	0.01	-0.06	0.03	-0.12	-0.14	0.05	-0.01	0	0	0.03	0.02	0.05
26.05.1997	0	-0.02	-0.01	-0.03	0	0.04	0.01	0.02	-0.12	0.03	-0.02	0.01	0.01	0	0	-0.03	0	0
02.06.1997	-0.03	-0.03	0.03	0	-0.02	-0.01	-0.01	0.01	0.12	-0.07	0.02	0	0	0	0	0	0	-0.04
09.06.1997	-0.01	0.06	-0.02	0.02	0.01	-0.02	-0.01	0	-0.06	0.08	-0.05	0	0.01	-0.01	0	-0.01	0	-0.02
16.06.1997	0.01	-0.01	0	-0.03	-0.02	0.01	-0.05	-0.02	0.07	0	-0.04	0.03	-0.01	-0.03	0	-0.06	0.01	-0.04
23.06.1997	0.03	-0.01	0.01	0.06	-0.01	0	0.02	0.01	0.02	0	0.01	0.06	0.03	0.01	-0.02	0	0	0.01
30.06.1997	-0.02	0.05	-0.03	0.02	-0.02	0.03	-0.01	0.07	0.01	0.04	0.02	0.07	0.04	-0.01	-0.03	0.02	-0.11	0.05
07.07.1997	0	-0.03	-0.03	0.05	-0.02	0.02	-0.02	0.05	0	-0.06	0	0.03	0	-0.07	-0.01	0.03	-0.01	-0.02
14.07.1997	-0.02	-0.03	0.01	0	-0.01	0.01	-0.01	0.03	0.02	0	0.01	0.05	0.16	0.07	-0.06	0	0	0.01
21.07.1997	0.01	0.01	0	0	-0.02	0	0.03	0.06	0.03	-0.02	0	0.21	0.22	0	0.01	0	-0.04	-0.02
28.07.1997	0.01	0	-0.01	-0.06	-0.01	0.02	-0.02	0.01	0	0	0	0.02	0.09	-0.02	-0.02	-0.01	0	-0.04
04.08.1997	0.01	0	0.02	-0.03	-0.01	-0.02	-0.01	-0.02	0	0.05	0	-0.06	0.06	-0.1	-0.02	0.02	0	0
11.08.1997	0	0	0	-0.01	-0.04	-0.03	-0.01	0.02	0.05	0.04	-0.07	-0.04	0.01	-0.01	0	0.09	0.1	0.01
18.08.1997	0.01	0.01	0	-0.13	0	0	-0.03	-0.05	-0.03	-0.04	-0.02	0	0	0.01	-0.03	0.11	0	0
25.08.1997	0.02	0.01	-0.01	-0.12	0.02	-0.02	-0.01	0	-0.01	-0.02	-0.11	-0.02	-0.05	0.1	0.01	0.01	0	-0.02
01.09.1997	0	-0.02	0	-0.01	0.02	0.02	-0.02	-0.02	0.01	0	0.04	0	0.05	-0.14	-0.02	-0.07	0	-0.01
08.09.1997	-0.01	-0.01	0	0.19	0	0	-0.04	0	-0.01	0	0.05	0	-0.07	0.03	-0.03	-0.01	0	0.01
15.09.1997	0	0.01	-0.02	-0.02	0.01	-0.04	0	-0.03	0.01	-0.01	0.03	-0.04	0	0.04	0.02	-0.04	-0.08	0
22.09.1997	-0.01	0	0	-0.1	0.01	-0.03	0.01	0.04	0.02	-0.04	-0.11	0	0	0	0.01	-0.12	0	-0.02
29.09.1997	-0.04	0	0	-0.05	-0.01	0.05	-0.01	-0.02	0.01	0	-0.07	-0.3	0	0.04	0	-0.1	0	-0.02
06.10.1997	0.05	-0.01	0.02	-0.03	-0.03	-0.02	0	-0.03	0	-0.03	0.01	-0.05	-0.31	0	-0.03	0.11	0	0.06
13.10.1997	0.05	-0.08	-0.02	0.15	0	0.01	0.02	-0.01	-0.01	0	-0.01	0.02	0.02	-0.03	0	0.04	0	0.01

20.10.1997	0.03	0.01	-0.05	0.01	0	-0.01	0.01	0.07	0	0	0.03	-0.02	0	0.01	0.01	-0.03	0	-0.01
27.10.1997	-0.01	0.01	0.01	0.03	0	0.04	0	0	0	0.01	0.03	0	0.02	0	-0.04	0.08	-0.15	0.01
03.11.1997	0.01	0	0	0	0	0.02	0	0	0	0	0.02	0.04	0.03	-0.01	0	0	0	0.01
10.11.1997	-0.01	0	0	0.05	-0.02	0	0.01	0	0.01	0	-0.02	0	0	0	0.05	0	-0.01	0.03
17.11.1997	0.02	0.12	0	0.04	0.02	0.04	0	-0.02	-0.01	0	0.03	0	0	-0.01	0	0.04	0	0.02
24.11.1997	0.04	0.06	-0.01	0.19	0	0.19	0.04	0.02	0.01	0.09	0.14	0	0.05	0.03	0.04	0.07	0.01	0.05
01.12.1997	0.01	-0.01	0	-0.01	0	0.05	0.17	0.01	0	0.01	-0.01	0	0	0.05	0.01	0.01	-0.04	0
08.12.1997	-0.03	-0.01	0	-0.05	0	-0.15	0.1	0.01	0.01	0.1	-0.04	0.15	0.14	-0.03	-0.01	-0.02	0	-0.01
15.12.1997	-0.01	-0.01	0	-0.04	0.02	-0.02	-0.09	-0.02	0	0.1	-0.03	0.01	0.08	0.02	-0.03	-0.03	0	-0.03
22.12.1997	0.05	0.01	0.05	0	-0.01	0.04	-0.06	-0.02	0.01	-0.07	-0.01	0	0.01	-0.01	-0.01	0.04	0	-0.01
29.12.1997	0.02	0	-0.01	0	0.01	0	-0.01	0.09	0	0.01	0	0.03	0	0	0.01	0.02	0	-0.03
05.01.1998	0.06	-0.05	0.03	-0.2	0	0.01	0.02	0.23	0.01	0	-0.01	0.12	0.09	0.01	0.03	0	-0.24	-0.02
12.01.1998	-0.01	-0.04	0	0.12	0	0.02	0	-0.01	0	-0.04	0.01	0.01	0	0	-0.02	0.01	0	-0.08
19.01.1998	0.01	-0.03	0	0.07	0	0.04	-0.04	-0.14	0	-0.01	-0.04	-0.11	0.04	0.01	0	0	0.01	0.03
26.01.1998	-0.07	0.04	0.01	0.04	-0.09	-0.04	-0.05	-0.04	0.02	0.34	-0.04	0.12	0.03	0	0	0	0	0
02.02.1998	-0.01	0	-0.02	0	-0.01	-0.05	-0.03	0.37	0.05	0.07	-0.07	0.04	0.03	0	-0.01	-0.05	-0.09	0.01
09.02.1998	-0.02	0	0.01	0	0	-0.05	-0.03	-0.01	0.01	0.01	0	0.03	0.02	0	0	-0.03	0	0.03
16.02.1998	0	-0.03	0	-0.13	0	-0.05	-0.06	-0.11	0.34	0	0.02	0	0.14	-0.09	-0.09	-0.05	0.01	0.01
23.02.1998	-0.02	0.02	0	-0.08	0	0.03	-0.03	-0.06	0.02	0	0.04	0	0.01	0.06	0.01	-0.03	-0.14	-0.03
02.03.1998	-0.02	-0.02	-0.01	0	-0.01	0.01	0.01	-0.02	0.01	0	-0.03	0	0.01	0	0.01	-0.01	0	-0.05
09.03.1998	0	0.02	-0.01	0.04	0.01	0.01	-0.03	-0.04	0.02	-0.01	0	-0.08	-0.03	-0.01	0.01	0.01	0	-0.01
16.03.1998	-0.01	-0.02	0	-0.08	0	0	-0.02	0.02	0.01	0	0	0	-0.05	-0.01	0.06	0	0	0
23.03.1998	0	0	-0.04	0.02	0	0.01	-0.02	-0.01	0.01	-0.01	0	0	0.06	-0.14	0.01	0.03	0	0
30.03.1998	0.03	0.03	-0.02	0.05	0.02	0.02	-0.04	0.01	0	0.02	-0.08	0.02	0	0.02	0.01	0.02	-0.03	0.08
06.04.1998	0.06	0.02	0.03	0	0	0.1	0.01	0.05	0	0	0.06	-0.02	0	0.12	0.01	0.01	0	-0.02
13.04.1998	0.07	0.01	0.01	0.06	0	0.01	-0.02	0.02	-0.01	-0.25	0.05	0	0.01	0.09	0	0.02	0	0.04
20.04.1998	0.02	0.05	0	0	0	-0.06	0.02	0.04	0.47	0.06	0.02	0.08	-0.02	0.01	0.03	0.04	-0.12	0.05
27.04.1998	-0.02	0.01	0.01	0.01	0	-0.04	0	-0.02	-0.21	0	-0.04	0.05	0.08	0.01	0	0.02	-0.01	-0.02
04.05.1998	-0.04	0.03	-0.01	0	0	0.05	0.01	-0.01	-0.09	-0.01	0.01	-0.12	-0.05	0.02	-0.03	0	0	0
11.05.1998	0.02	0.02	0.02	0	0.01	0.06	0.01	-0.02	0.03	-0.19	0.02	0.18	-0.09	0.05	-0.01	0.02	-0.19	-0.03
18.05.1998	0	0	0	0	0	-0.07	-0.01	0	-0.01	-0.06	0	0.01	-0.01	0	0	-0.03	0	-0.01
25.05.1998	-0.02	0.05	0.03	-0.02	-0.02	-0.02	0.01	0	0.04	-0.11	0	0.01	-0.04	0.01	-0.09	-0.09	0	0.01
01.06.1998	-0.03	0.01	0.01	-0.01	0.03	0.01	0	0	-0.03	0	0	0	-0.16	0.02	0	0.12	-0.01	-0.04
08.06.1998	0	0.01	0	-0.1	0.01	-0.01	0.01	0	0.06	0	0.01	0	0.06	0	0	0.02	-0.01	0.01
15.06.1998	0.03	0.02	0	-0.04	0	0.01	-0.02	0.02	-0.03	0.01	0.01	-0.04	0.09	0.02	0	0.02	0	-0.02
22.06.1998	0.01	0.02	0	-0.02	0.03	-0.02	0	0	0.06	0.01	0.01	0	0	0	0	0	0.02	0.02
29.06.1998	0	0	0	-0.02	0.03	0.03	0	-0.02	-0.01	-0.02	-0.01	0.05	0	-0.02	0	0	-0.03	-0.01
06.07.1998	0.01	0	-0.03	0.06	0.02	0	0.03	-0.02	0.02	0	-0.01	0	0.01	0.01	0	-0.01	0	0.01
13.07.1998	0.01	0.03	0	-0.07	0	0.01	-0.02	0.03	0	0.01	0	0.01	0	0	-0.07	0	0	-0.01
20.07.1998	-0.03	-0.02	0	0.04	0.01	0.01	0.01	-0.01	0.01	-0.01	0	-0.01	0	0	0.01	-0.01	0.01	0.06
27.07.1998	0	0	0	0.04	0.02	0	-0.04	0.03	0	0	-0.05	0.01	0	-0.01	0.02	-0.01	0	0.01
03.08.1998	0.01	0	0.01	-0.06	0.03	0.03	-0.01	-0.01	-0.01	0	-0.03	0.01	0	-0.07	0.02	-0.01	0	-0.06
10.08.1998	0.01	-0.01	0.02	-0.01	0.01	-0.03	-0.03	0.04	0	-0.02	-0.02	-0.08	0.02	0.02	0.02	-0.05	0	-0.01
17.08.1998	0.01	0.01	0	-0.01	0.04	-0.01	-0.02	-0.01	-0.1	-0.03	-0.06	0	0	0	-0.02	0.01	0	0.01
24.08.1998	0	0	0.01	0.04	0.01	0.01	0.02	-0.03	-0.06	0	-0.01	0	0	-0.04	-0.02	0.05	0	-0.02

31.08.1998	0	-0.02	0	-0.03	0.02	0.03	0	0	0.05	0.01	0.01	-0.03	0	-0.01	0.04	-0.01	0	0
07.09.1998	0.01	-0.04	0	0	0.02	0.02	-0.04	-0.01	0.08	-0.04	-0.01	0.03	0	-0.01	0.01	0	-0.14	0
14.09.1998	0.01	-0.03	0.01	-0.01	0.01	-0.01	0.02	0.01	0.01	-0.06	0.01	0	0	-0.05	0.02	0	-0.04	0.01
21.09.1998	0.01	-0.08	0	-0.08	-0.01	-0.03	-0.05	-0.04	0	-0.38	0.02	-0.02	0.02	0.09	0.02	-0.08	0	0.01
28.09.1998	0	-0.03	0	-0.02	0.02	-0.06	0.01	-0.03	0	0	0.01	-0.01	0	0.01	0	0	0	0.01
05.10.1998	0.01	0	-0.01	0.05	0.01	-0.08	0.01	0.01	0.02	0.17	0	-0.02	0.01	0.01	-0.01	0	0	0.02
12.10.1998	0.03	0.06	0.02	-0.01	0	0.02	-0.02	-0.08	0.01	0.12	-0.06	0.03	0	-0.01	-0.02	-0.04	-0.03	0.01
19.10.1998	0.06	0.01	0.01	0	0.07	0.04	0.01	0.08	0.02	0.04	-0.05	0	0.03	0.01	0.03	0.01	0	0.03
26.10.1998	0.09	0.01	0	0.03	0.05	0.09	0.09	0	0	-0.01	0	0.02	-0.03	0.05	0.07	0.03	0.01	0.05
02.11.1998	0.08	0.07	0	0.32	0.11	0.09	0.03	0	0.08	0.07	0.13	0.01	0	0.1	0	0.03	0.02	0.14
09.11.1998	-0.04	0.02	0	0.02	0.09	-0.03	0.18	0	-0.01	0.09	0.04	0	0.05	0.17	-0.05	0.02	-0.01	0.06
16.11.1998	0.04	0	0	0	0.03	-0.01	0.09	0	0.01	0.05	0.01	0.01	-0.01	0	0.05	0.04	0	0
23.11.1998	0.02	0	0	0.04	0.03	0.03	0.01	0.05	0.03	0.33	0	0	-0.02	-0.12	0.02	0.05	0	0.01
30.11.1998	0.01	0	0.01	0.04	0.01	0.01	0.12	0	0	-0.08	0.1	0	0.05	0.01	0.02	0.1	0.12	-0.03
07.12.1998	-0.06	0	0.01	-0.07	-0.01	-0.01	-0.01	0.01	-0.01	-0.02	-0.06	0	0	0.05	0.08	-0.07	0	0.02
14.12.1998	-0.01	0	0.04	0.02	-0.07	-0.01	-0.07	-0.05	-0.05	-0.01	0	0	-0.02	-0.07	0.02	-0.04	0.12	-0.11
21.12.1998	0.07	0	0	-0.01	-0.1	0.02	-0.05	0	0	-0.01	0	0	-0.05	0.02	0	0	-0.02	0.01
28.12.1998	0	0	0	-0.07	0	0.02	-0.07	-0.05	0.01	0	0.03	0	0.01	-0.01	0.02	0	-0.01	0.02
04.01.1999	-0.01	0	0	-0.02	0.17	0.03	-0.06	-0.03	0.01	0	0	0	0	0.02	0.01	-0.01	0.02	0.04
11.01.1999	-0.03	0	-0.18	-0.09	0.08	0.03	0.01	-0.07	0.01	-0.12	-0.06	0.03	0.03	0.07	0	0.01	0	-0.01
18.01.1999	-0.02	0.01	0.14	0	0.06	0.03	0.25	-0.01	0.01	-0.01	-0.07	-0.02	-0.01	0	0	0	-0.01	0.01
25.01.1999	-0.02	0	0	-0.01	0	0.02	-0.15	0.01	-0.01	-0.19	0.01	-0.01	0	0.02	0	-0.04	0	0.01
01.02.1999	-0.12	0	0.01	0	-0.05	0.02	-0.07	-0.01	-0.01	0.03	-0.07	0.02	0	0.09	-0.04	-0.03	0	-0.03
08.02.1999	0.06	-0.02	0	0	0.02	0	0.01	0	0	-0.03	-0.07	0	0	-0.02	0	-0.04	0	0.03
15.02.1999	0.02	0.03	0	0	0.01	-0.02	0.09	-0.02	-0.01	0.01	-0.02	-0.16	0	-0.01	0.01	-0.04	0	-0.02
22.02.1999	-0.01	0	0	0	0.01	0.01	0.01	-0.03	0	-0.01	-0.06	0.1	0	0.05	-0.01	0	0	0
01.03.1999	0	0	-0.03	0	0.03	0	0	0	0.01	-0.03	0.06	-0.05	0.01	-0.01	0	0.06	0	0.01
08.03.1999	0	0.01	-0.01	-0.01	0.11	-0.03	0.01	0.04	0	-0.04	-0.08	-0.04	-0.01	0.06	0.02	0	0	0
15.03.1999	-0.03	0.01	0.02	-0.13	0.01	0	0.01	-0.02	0.01	0	-0.01	-0.02	0	0.01	-0.01	0.01	-0.03	-0.01
22.03.1999	0.01	-0.01	0.01	-0.07	-0.01	-0.01	0.03	-0.01	-0.01	0.01	0	0	0.01	0	0	-0.02	0	0.01
29.03.1999	0.02	0	0.01	0.03	0.02	0.01	0	0.01	-0.12	0.03	0	-0.02	0	0.01	-0.04	0	-0.08	-0.06
05.04.1999	0	0	0	-0.03	0.02	0	-0.04	-0.1	0.11	0	0.03	-0.03	0	-0.02	0	-0.04	-0.04	0.02
12.04.1999	0	0.01	0.01	0.03	-0.03	0.01	0.04	0	-0.01	0.03	-0.03	0.07	0	0.03	-0.03	0.02	-0.12	0.09
19.04.1999	-0.01	0	0.01	0.01	0	0	-0.02	0.02	-0.14	0.01	0.02	-0.03	0.01	-0.01	0.02	0	0	-0.02
26.04.1999	0.01	0	-0.01	0.15	0.01	0.03	0.03	0.03	0.14	0	-0.02	0.04	-0.01	0	0.01	0	0	0.03
03.05.1999	0	0	0.01	-0.09	0.01	-0.02	0	0	-0.01	0	0	0	0.01	0	0.03	0	0	0.01
10.05.1999	0.01	-0.01	0	-0.01	0	0	0	0	0.01	0	0	0	0	0.01	-0.04	-0.01	-0.01	0.02
17.05.1999	0.02	0.01	0	0.02	-0.04	0	0.01	0	0	0	0.01	0	-0.01	0.02	-0.01	-0.01	0	0.02
24.05.1999	0.02	0	-0.05	0.13	-0.06	0.02	0.03	0	0.02	0	0.06	0.01	-0.01	0.01	-0.01	0	0	0.03
31.05.1999	0.04	0	0	-0.03	-0.02	0.01	0.01	0	0	0	0.07	0	0	0.01	0.01	0.02	0	0.06
07.06.1999	-0.01	0	0.05	0.01	-0.03	0.01	0.02	0.01	-0.01	0	-0.07	0.03	0	0	0.01	-0.02	-0.01	0.01
14.06.1999	0.01	0	0	0.05	-0.02	0.01	0	-0.01	0	-0.01	-0.05	-0.02	0	0	-0.01	0.01	0	-0.01
21.06.1999	0.02	0	0	-0.01	-0.04	0	0.01	0	-0.02	0.01	0.01	0	0	0.02	0.01	0	0	0.01
28.06.1999	-0.03	0	-0.01	0	0.03	-0.02	0.01	0.02	-0.05	0	0.01	0	0	0.02	0.02	0.01	0.01	0.04
05.07.1999	-0.06	-0.24	0	0	0	0.03	0	0	-0.07	-0.44	-0.13	0	0	0.03	0.06	-0.01	-0.02	0.01

12.07.1999	0	0	0	-0.02	0.02	0	0.02	0	-0.06	-0.04	0.01	0	0	0	-0.09	-0.03	0.03	-0.02
19.07.1999	-0.08	-0.15	0	0.03	0.01	0	0	0.04	0.05	0.04	0.03	0	-0.18	-0.01	-0.04	-0.05	0	-0.01
26.07.1999	0.04	0.07	0	0	0.04	0	0	0	0	0.16	-0.06	0	0	-0.01	-0.01	-0.01	-0.28	0.01
02.08.1999	0	-0.02	0	-0.06	0.02	-0.02	-0.03	-0.02	-0.03	0.11	-0.04	-0.17	0	-0.03	0.01	0	0	0
09.08.1999	-0.04	0.01	0	-0.05	0.01	-0.01	-0.03	-0.01	0.01	0	-0.05	0	0	0.05	0.03	-0.02	0	0
16.08.1999	0.01	0.02	0	0.01	0	-0.05	-0.03	0	0	0	0.02	0	-0.02	0.01	0.11	0	0	0.01
23.08.1999	0.02	0	0	0	0	0	-0.02	0.02	0	-0.32	0.03	-0.01	0.01	-0.05	0.04	0.02	0.01	0.02
30.08.1999	0.02	0.01	0	-0.03	0	-0.01	0.02	-0.03	0	0	-0.01	0	0	-0.01	-0.04	-0.02	0	0.01
06.09.1999	0	-0.01	-0.03	0	0	0.02	0.03	-0.02	-0.01	0.15	0	0	-0.04	-0.01	0.04	-0.03	0	0.02
13.09.1999	0	0	0	0.01	0.01	-0.12	0	0	0.03	0.04	-0.04	0	0	0	-0.02	-0.11	0	0.02
20.09.1999	-0.02	0.03	0	-0.01	-0.08	-0.06	0.01	0	-0.06	0.03	-0.03	0	0.02	-0.1	-0.03	-0.04	0	0.01
27.09.1999	0	-0.01	-0.04	-0.03	-0.01	0	0	-0.08	0.03	0	-0.11	0	-0.03	0.01	-0.01	0.01	0.03	0.02
04.10.1999	0.01	-0.01	0	0.06	0.02	0	0	-0.03	-0.05	0.05	0	0.01	-0.04	-0.07	0.02	0	0	0
11.10.1999	0.02	0	0.04	-0.03	0.04	-0.05	0	-0.07	0.01	0.07	0.11	-0.06	-0.08	0.14	0	0.02	-0.32	0
18.10.1999	0	0.01	-0.01	0	-0.06	0.03	0.01	0	0.01	0.08	-0.01	-0.03	-0.03	-0.05	0.02	0.02	0.57	-0.06
25.10.1999	0	0	0	0.01	0	0.03	0	0	-0.03	0	0.03	0.03	-0.01	-0.03	-0.02	0	0	0.02
01.11.1999	-0.04	0	0	-0.01	0	0.04	0	-0.12	-0.01	0.04	-0.12	0	0	0.02	0.03	-0.01	0	-0.03
08.11.1999	0	0	0	0.01	0	-0.01	-0.02	-0.01	-0.01	0	0.01	0	0	0.01	0	0.01	0	0.02
15.11.1999	0.02	-0.06	0	-0.01	0.01	-0.02	0.02	-0.06	0	-0.03	-0.03	0	-0.03	0.01	0.01	-0.02	0	0.12
22.11.1999	0.15	-0.17	0	0	0.17	0.02	0.07	0	-0.01	-0.02	0	-0.08	-0.02	0	0	0.03	0	0.21
29.11.1999	0.02	0	0	0	0.13	0.03	0.18	-0.03	0.01	0	0	-0.15	-0.02	0.04	0.08	-0.04	0	-0.01
06.12.1999	-0.02	0.22	0.01	0	0.01	0.03	-0.15	0	-0.01	0	0	0	0	0.01	0	0.01	0.02	0.01
13.12.1999	-0.18	-0.04	0	0.04	-0.14	0.02	-0.08	0.03	0	0.01	0	-0.09	0	0.02	-0.02	-0.03	0	0
20.12.1999	0.24	-0.04	0	0.04	0.02	-0.07	0.01	-0.03	-0.01	0.35	-0.06	0	0	-0.05	-0.01	0.01	0	-0.03
27.12.1999	0	-0.08	0	-0.05	-0.01	0.04	-0.01	0	-0.01	0.34	-0.06	0	0	-0.02	0	-0.01	0	0.08
03.01.2000	0	-0.05	0	0.01	0.01	-0.01	0.02	-0.02	-0.06	-0.01	0.04	0.02	0	0.02	-0.02	-0.04	0	0.02
10.01.2000	0.01	-0.01	0.01	-0.01	0.01	0	0	-0.15	-0.13	0.05	0.07	-0.01	0.03	0.03	0.02	-0.08	0.02	0.01
17.01.2000	0	0	0	-0.02	0.01	0.03	-0.01	0.07	0.02	0.03	0.01	-0.03	0	-0.03	0	-0.02	0	0
24.01.2000	-0.01	0	-0.03	0.02	-0.06	-0.03	0	0	0.02	0.01	-0.07	0	0	0	-0.07	0.01	0	-0.07
31.01.2000	0.01	0	-0.05	0.06	0.01	0	0	0.05	0.02	-0.01	-0.13	0	0	0.02	0	0	0	-0.02
07.02.2000	-0.01	0	0.05	0	0	0	0	0.06	0	-0.04	0.16	-0.02	-0.1	0	-0.19	-0.15	0	-0.01
14.02.2000	0	0.01	-0.11	0	0.01	-0.01	0.01	0.04	-0.01	-0.07	0	0	-0.05	0	0.03	0.01	0	0.03
21.02.2000	0	-0.03	-0.1	0.01	0	0	0	0.06	0	-0.07	0.03	0	0	-0.01	0.01	-0.09	0	0
28.02.2000	-0.03	0	0	0	-0.01	-0.01	0.01	-0.04	-0.01	0	-0.03	0	0	-0.04	0	-0.16	0	-0.01
06.03.2000	-0.01	0	0	0.01	-0.01	-0.01	-0.01	0	0	0.01	-0.03	-0.01	0	-0.03	0.01	-0.01	0	-0.04
13.03.2000	0	0	-0.14	0	-0.02	0.01	0.01	-0.04	0	-0.24	-0.02	-0.04	-0.02	0.04	0.01	0	0	0.04
20.03.2000	0.01	-0.01	0	0.01	-0.03	0.01	0.01	0	0	-0.09	0.06	0	-0.01	-0.03	-0.05	0.01	0.02	0.01
27.03.2000	0	0.01	0	0	0.02	0.01	0.02	0	0	-0.06	0.01	0	0	0.02	0	0	-0.01	0.01
03.04.2000	0.01	-0.01	0	0.01	0.06	0	0.03	0	0	0	-0.06	-0.01	-0.04	0.03	-0.01	0.02	0	0.01
10.04.2000	0	0	0.09	0.05	0	0	0.03	-0.02	0.01	-0.09	0.02	-0.02	-0.01	0.01	0	-0.02	-0.02	0.06
17.04.2000	0	0	0	0.04	0.01	0	-0.01	0	0	-0.01	-0.07	0.02	0	0.01	0	0.03	0.08	0.01
24.04.2000	-0.02	0.01	0	0	0	0	-0.01	-0.01	0	-0.04	-0.04	0	0	0.01	-0.01	-0.03	0.01	0.01
01.05.2000	-0.04	0	-0.06	0	0	-0.03	0.02	0.01	0	0	-0.01	0	-0.05	-0.01	0.01	0.01	-0.02	0.02
08.05.2000	0.04	-0.07	-0.02	-0.01	0.05	0.02	0.04	-0.01	0	-0.01	0	0	-0.06	0	0	0.01	0	0.03
15.05.2000	0.01	0.06	0	0.01	0	0.01	0	0	0	-0.01	-0.02	0	-0.07	0.07	-0.03	-0.03	0.05	0.01

22.05.2000	0.01	0.05	-0.04	0	0.01	0.03	0.01	0	-0.04	0	-0.05	0	0	0.07	-0.07	-0.03	0	0.01
29.05.2000	0.01	-0.02	0	-0.01	0.02	0	-0.02	0	0.04	-0.07	0.09	0	0	-0.01	0	0	0	0.02
05.06.2000	0	0.08	0	0.01	0.03	0.01	-0.03	0.03	0	-0.04	0.03	-0.04	0.05	0.02	-0.01	-0.02	0	0.02
12.06.2000	0.01	0.01	0.03	0.01	0.09	0.01	0	-0.08	-0.01	0.01	0	0.02	0.03	0	-0.16	-0.02	0	0.01
19.06.2000	0.01	0	-0.02	-0.01	0	0.01	0.02	-0.01	-0.07	0.04	0	-0.04	0.01	0.01	0	0	0	0
26.06.2000	0.01	0.02	0.04	0.01	-0.02	0	0.01	0.01	0	0.1	0.06	-0.07	0.08	0	0	-0.02	0	0
03.07.2000	0.02	0.01	0	0.02	0	0.03	-0.02	0.06	-0.01	0.06	0.02	0	0	0.02	0.07	-0.02	-0.01	0
10.07.2000	0.02	0.07	0	0.02	0.01	0.03	0.01	0	0.04	-0.04	0.01	0.04	0.08	0	0	-0.05	0	0.01
17.07.2000	0.03	0.03	0	0	0.01	0.01	0	0	-0.01	-0.05	0.04	0.04	0.16	0	0	-0.25	0	0
24.07.2000	0.02	-0.01	0	0.01	-0.01	0.03	0.01	0	0.03	-0.09	-0.04	-0.12	0.04	0.01	0	0.21	0	0.01
31.07.2000	0.01	0.03	0.02	-0.01	0	0.04	0	0	-0.01	-0.04	0.05	-0.01	0	0.03	-0.01	0.13	-0.65	0
07.08.2000	-0.1	-0.01	0	0	0.01	-0.01	0.01	0.01	0.01	-0.05	0	0.04	0	0	-0.05	0.02	0	-0.04
14.08.2000	-0.02	0.06	0.01	0	-0.01	0	-0.01	0.02	-0.02	-0.05	0	0.02	-0.01	0	-0.03	0.03	0	-0.05
21.08.2000	-0.03	0	0	0	0.01	0	0	0	0	0	0	0.01	0	-0.01	-0.01	0.03	0.2	0
28.08.2000	-0.01	0.01	0	0.01	0	-0.08	-0.01	0.01	0.01	0.04	-0.01	-0.01	0	0	0.01	-0.02	0	0.01
04.09.2000	-0.04	0	0.06	0.01	-0.05	0.01	-0.01	0	0.01	0.01	-0.02	0	0.01	-0.05	-0.03	0.01	0	0
11.09.2000	-0.09	0	0	0.01	-0.04	0.01	0	0	-0.01	0	-0.17	0	0	-0.04	-0.02	0	0.15	-0.09
18.09.2000	-0.12	0.01	0	0	-0.1	0.02	-0.01	-0.03	-0.02	0	-0.12	0	0.07	0	0	-0.02	0.08	-0.08
25.09.2000	0.22	0	0	0	0.05	0.03	0	0.01	-0.01	0	0.23	0	0	0.01	0	-0.11	0	0.2
02.10.2000	0	0	0	0.01	0.07	-0.02	-0.06	-0.02	0	-0.01	0.04	0	-0.03	0.01	0	0.03	0	0.07
09.10.2000	0.06	0	0	-0.01	0.02	0.01	-0.04	-0.05	-0.02	0.01	-0.22	-0.58	0	0.02	0.03	0.02	0	-0.03
16.10.2000	-0.04	0.01	0.01	0.01	-0.01	0.02	-0.01	0	0.01	0	-0.01	0	0.03	-0.03	-0.01	-0.02	0.1	-0.04
23.10.2000	-0.06	0	-0.01	0	-0.01	0.05	-0.01	0	0.03	0	0.01	0	0.01	0.01	-0.02	0	0	-0.06
30.10.2000	0.02	-0.01	-0.01	0	0	0	0	0.01	0	0	0.02	1.27	0	0.02	-0.06	0.02	0.07	0.07
06.11.2000	0.02	-0.1	0	0.01	0	0	-0.1	0.09	0.01	-0.03	-0.01	0.05	-0.02	0.01	-0.01	0.02	0	0.03
13.11.2000	0.02	0.13	0	-0.02	-0.04	-0.03	0	0.02	0	-0.01	0.01	0	0.02	0	0	0.29	0	-0.01
20.11.2000	0	0.04	0	-0.12	0.01	0	0	-0.07	0.01	-0.04	-0.02	-0.02	0	0.01	0.02	-0.06	0	0.04
27.11.2000	0.04	0.01	-0.09	0.03	0	0	-0.1	0.06	0	-0.03	0.19	-0.02	0.07	0.02	0.02	0	0	0.12
04.12.2000	0.04	-0.01	0	-0.05	-0.03	-0.01	-0.04	-0.01	-0.01	0	0.12	0	-0.02	0	-0.04	-0.03	0	-0.03
11.12.2000	-0.05	0	0	-0.05	-0.02	-0.05	0.08	-0.07	-0.01	0.02	-0.01	0	0	0	0	-0.05	0	0.02
18.12.2000	-0.01	-0.02	-0.01	0	-0.02	-0.02	0.03	0.1	-0.02	0.08	-0.1	-0.12	0	-0.01	0	-0.14	0	0.01
25.12.2000	0.03	0.03	0	0	-0.01	0.01	0.01	-0.08	-0.07	0.01	0.04	0	-0.03	0.01	0	0	0	-0.19
01.01.2001	0	-0.06	0.01	0	0.05	-0.02	0.03	-0.03	-0.06	0	0	-0.12	0	0.01	0.02	0	0.02	0.08
08.01.2001	0	0	-0.05	0	-0.01	0	0.02	0	0	0	0	-0.01	0	-0.01	-0.02	0	0	0.01
15.01.2001	0	0	0	-0.04	-0.06	0	-0.03	-0.03	-0.06	-0.02	0.06	0	0	0.01	0	0	0	0
22.01.2001	0.01	-0.01	0	-0.03	0.03	-0.02	0.01	-0.03	0.02	-0.13	-0.01	0	0	0	0	-0.03	-0.01	0
29.01.2001	-0.09	0.03	0	0.07	-0.03	-0.02	0.05	0	-0.02	0	0	0	0	-0.02	0	-0.1	0	0.02
05.02.2001	-0.02	-0.01	0	0	-0.02	0	-0.02	0	-0.02	-0.09	0.04	-0.03	0.02	0.01	0	-0.12	-0.07	0.01
12.02.2001	0.01	0	-0.13	0	0	-0.07	-0.02	-0.02	-0.06	-0.06	0.11	0.03	-0.02	0	-0.07	-0.07	-0.02	0
19.02.2001	0	-0.02	0	0	-0.01	0.06	-0.03	0	-0.05	-0.02	-0.03	0.02	0	-0.02	-0.03	0	0	0
26.02.2001	0.02	0.02	-0.11	0	-0.01	0	-0.04	0.01	-0.08	0	-0.05	0	0.06	-0.04	0	0	0	-0.03
05.03.2001	0.08	0.01	-0.09	0	0.03	0	-0.02	-0.09	-0.05	0	0.02	-0.04	-0.03	0.03	-0.06	0	0	0.02
12.03.2001	-0.01	-0.01	-0.03	-0.01	-0.03	0.01	-0.06	0.03	-0.03	-0.1	-0.06	0.02	0.01	0.01	0	0.01	0	0.03
19.03.2001	0.03	0.01	0.02	0.03	-0.02	-0.01	0.01	-0.04	0.03	0	0.03	0	0.01	-0.01	0.02	0.01	0	0.04
26.03.2001	0.07	0.01	0.11	0.1	0.01	0.04	0.05	-0.01	0.09	0	0.03	0	0	0.03	0.01	0.01	0	0.03

02.04.2001	-0.01	0	0	0.09	0.02	0	0	0	0.08	0	-0.02	0	0	0	-0.02	0	0	-0.02
09.04.2001	-0.05	0.01	0	-0.02	-0.02	0	0.02	0.01	0.01	-0.03	-0.04	0	0	0	0	-0.06	0.01	-0.02
16.04.2001	0.01	-0.02	0	-0.01	0.04	0	0.02	-0.01	0	-0.08	0.01	-0.03	0.01	0	0	0.03	0	0
23.04.2001	0.01	0.01	-0.02	0.04	0	0	-0.05	-0.01	-0.03	0	-0.04	-0.06	-0.05	0.01	0	-0.03	0	0.02
30.04.2001	0.01	-0.03	0	-0.02	-0.11	-0.01	-0.05	0	0.01	0	0.18	-0.02	0.01	0	0.01	0.02	0	0
07.05.2001	0.01	0	0.01	0	0	-0.01	0	-0.06	0	-0.06	-0.04	-0.02	-0.01	0.02	-0.01	-0.02	0	0.02
14.05.2001	-0.03	0	-0.02	-0.07	0	0	0.01	0.01	-0.02	-0.01	-0.07	0	0.01	-0.01	0	-0.09	0.02	-0.02
21.05.2001	-0.01	-0.02	0	-0.02	-0.05	-0.07	-0.06	0	0	0	-0.05	0	-0.02	-0.02	0.02	-0.03	0	-0.09
28.05.2001	-0.03	0	0.02	0	0.01	-0.01	-0.05	0	0.01	0	0	-0.03	-0.05	-0.01	-0.02	-0.06	0	-0.06
04.06.2001	-0.05	-0.04	-0.02	-0.05	-0.01	-0.01	0	0	0	0	0	0	0	0.03	0	-0.01	-0.06	-0.01
11.06.2001	-0.02	-0.03	0	-0.01	-0.01	-0.03	-0.11	-0.1	0	0	-0.03	0	0	0.01	0	-0.11	0	-0.04
18.06.2001	-0.02	0.01	-0.02	0	-0.03	-0.04	-0.05	-0.12	-0.1	0	-0.06	0	0	0	-0.04	0.02	0.06	0.02
25.06.2001	0	-0.04	0.02	-0.01	0.03	-0.01	-0.09	0	-0.03	-0.13	0	0	0	0	0	0.12	0.01	0.1
02.07.2001	0	-0.01	0	-0.05	0.02	-0.02	-0.01	0	-0.05	-0.07	0.01	0	0	0	-0.11	0.12	0	0
09.07.2001	0.05	0.01	0	0	0.02	0.06	-0.02	-0.03	0.04	0	0.01	0	-0.03	0	-0.13	0.03	-0.07	0.01
16.07.2001	0.04	0.01	-0.05	-0.03	0.04	0.08	0	-0.01	0.04	0.52	0.08	0.06	0	0	0.02	0.03	0	0
23.07.2001	0.01	0.02	-0.01	0.03	-0.01	0.07	0.1	0	0.09	0.04	0.2	0.02	0.01	0.03	0.06	0	0	0.01
30.07.2001	-0.04	0.01	0	0	0	-0.18	0.1	0	0.06	0.1	-0.03	0	0.02	-0.01	0	-0.2	0	-0.03
06.08.2001	-0.02	0	0	-0.05	-0.01	0	0.01	0.01	-0.02	0.32	-0.08	0	0	-0.03	0	-0.18	0	-0.02
13.08.2001	0.03	0	0.04	-0.05	0.01	0	-0.04	-0.1	-0.02	0.03	-0.11	0	0	0.01	0	-0.03	0	0.03
20.08.2001	0.01	-0.01	0.02	0	0.01	-0.05	0	0.05	-0.02	-0.01	-0.02	0	-0.18	-0.07	0.01	0.05	0	-0.01
27.08.2001	-0.01	0	0	-0.1	0.02	-0.04	0	-0.02	-0.06	0	-0.04	0	-0.1	0	-0.01	0.09	0	0.02
03.09.2001	0.03	0	0.06	-0.01	0	-0.04	-0.01	-0.07	-0.03	0	0	0	-0.01	0	0	-0.01	0	0.02
10.09.2001	-0.02	-0.04	-0.04	0	0.01	0.01	-0.01	0	0	-0.04	0.01	0	0	0	-0.02	-0.01	0	0.01

REFERENCES

Defuso, Mcleavey, Pinto, Runkle; (1999), "*Quantitative Methods for Investment Analysis*"

Donald E. Fischer & Ronald J. Jordan, (1982), "*Security Analysis & Portfolio Management*", Risk and Return, 5th edition.

Edwin Elton & Martin Gruber, (April 1974), "*On the Optimality of Some Multi-period Portfolio Selection Criteria*", Journal of Business 47.

Eugene F. Fama, (June 1972), *Components of Investments Performance*", Journal of Finance, volume 3, p 551-567.

H.L. Royden, (1968), "*Real Analysis*", 2nd edition, Stanford University, US.

Henry Latane and William Avera, (April 1973), "*Portfolio Performance Evaluation and long run Capital Growth*", Working Paper, University of North Carolina-chapel Hill.

Wonnacott, T. H., (1962), "*Introductory Statistics for Business and Economics*", 4th edition, p32-35.

Jack L. Treynor; (Jan-Feb 1965), "*How to Rate Management of Investment Funds*", Harvard Business Review 43, p 63-75.

James C. T, Mao; (December 1970), "*Essentials of Portfolio Diversification*", The Journal of Finance, volume25, number 5, p 1109-1121.

Jeffery Laderman; (Feb 4, 1985), "*Why Money Managers Don't Do Better*", Business Week, p 58-65

Joanne M. Hill; (Summer, 1981), "*Is Optimal Portfolio Management Worth the candle?*", The Journal of Portfolio Management, Volume 7, Number 4, p 59-69.

John. O. Odhiambo, (2000), *"Determining The Accuracy Of The Nairobi Stock Exchange 20-Share Index"*, Unpublished MBA Thesis, University Of Nairobi

Latanes Bequest; (winter, 1986), *"The Best of Portfolio Strategies"*, Journal of Portfolio Management, p 21-30.

Markowitz, Harry M., (1991), "*Portfolio Selection*", second edition, Blackwell

Michael C. Jensen; (23, May 1968), *"The Performance of Mutual Funds in Period 1945-1965"*, Journal of Finance, p 389-416.

R.G Ibbotson and R.A Sinquefield, (1982), *"Stocks, Bonds, Bills and Inflation (SBBI)"*, Charlottesville, Va: Financial Analysts Research Foundation

Reilly and Brown, (1997), "*Investment Analysis and Portfolio Management*", 5th edition, the Dryden press.

Richard W. McEnally; (September 1983), *Journal of Finance*, Vol.38, No.4, p1087-1092.

Silviu Lulian; (2001), *The Relative Value Theory*, article , Tulane University.

Son-Non-Chen and Stephen J. Brown; (September 1983), *"Estimation Risk and Simple Rules For Optimal Portfolio Selection"*, The Journal of Finance, Volume 38, number 4, p1087-1092.

Stephen Sears & Gary Trennepohl, (1993), "*Investment Management*", the Dryden press.

Weston and Copeland, (1992), *Financial Theory and Corporate Policy*", 3rd edition, Addison Wesley.

William H. Jean; (March 1980), *"The Geometric Mean and Stochastic Dominance"*, Journal of Finance, 35, p 151-158.

APPENDIX iii

Weekly returns (percentage) of shares listed at NSE for the period 1996 to 2001

Week	BBK	BBond	BOC	BAMB	BAT	UCHUMI	Total	SASINI	NMG	KNM	KCB	KAKUZI	GWK	EABL	DTK	KPLC	EAPACK	SCB
04.03.1996	0	-0.01	0	-0.01	0	-0.01	0	0	-0.06	-0.04	0.06	-0.05	-0.09	0.07	0	-0.03	0	-0.03
11.03.1996	0.02	0.02	0	0	0	-0.01	-0.02	0.02	0.04	0	-0.11	-0.01	-0.02	0	-0.02	0	0	-0.03
18.03.1996	0.07	0	0	0.12	0.02	0.02	-0.01	0.15	0.05	0.02	0.1	0.03	-0.01	-0.06	0	0.02	0	0.12
25.03.1996	-0.02	0.01	0	0.08	0	0.01	0.01	0.1	0	0.02	0.02	0	0	0.01	0.01	-0.02	0	0
01.04.1996	-0.01	0.01	0	-0.05	0	0	0.06	-0.02	0.01	0.03	0	0.04	0	0.01	0.02	-0.04	0	0.01
08.04.1996	0.01	0	-0.04	-0.02	0	0	0.01	-0.01	0	-0.04	0.03	0.06	0.12	0.02	0	0.07	-0.01	0.01
15.04.1996	-0.01	0	0	0.01	0	-0.01	0.08	0.02	0.01	-0.02	-0.03	0	0.01	0	-0.01	-0.02	0	0
22.04.1996	0	0	0	0.08	0.01	0.02	-0.02	-0.01	0	0.01	-0.04	0.02	0	0	-0.03	0.03	-0.01	0.03
29.04.1996	0.01	-0.01	-0.01	0	0.02	-0.02	-0.03	-0.03	0.02	-0.02	-0.08	0.01	0.04	0.01	0.04	0.03	-0.01	0.04
06.05.1996	0	0.02	-0.02	0.02	-0.01	0.02	-0.04	-0.03	0.01	0	0.07	0.03	0	0.02	0.02	0.01	0.02	0.02
13.05.1996	-0.01	0	0	0	0.04	0	-0.06	-0.03	0.08	0	0.03	0	0	0.1	0.01	0.02	0	-0.01
20.05.1996	-0.02	0	0.03	0.03	-0.02	0.08	0.01	0	0.01	0	0	0.02	0.09	-0.01	0.03	0.06	0.01	0.02
27.05.1996	-0.01	0	-0.06	-0.03	0	0.03	0.01	0	0.02	0	0	-0.03	0.03	0	0	0.05	-0.01	0.01
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
17.06.1996	0.01	0	-0.01	0	0	-0.01	-0.01	0	0.03	0.04	0.01	0	0	0.05	-0.01	0.04	0.02	-0.01
01.07.1996	[illegible]	0	0	[illegible]	[illegible]	[illegible]	[illegible]	-0.1	[illegible]	[illegible]	[illegible]	0.01	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
08.07.1996	0	0	0	0.01	0	0.05	0	0.05	0.01	0	-0.05	0	0.03	0	-0.02	-0.01	0	0.02
15.07.1996	-0.02	-0.03	0.01	-0.01	-0.01	-0.01	-0.04	0	0.02	-0.02	-0.02	0	0.02	-0.02	-0.2	-0.01	-0.02	-0.01
22.07.1996	0.01	0.02	-0.01	0	-0.01	0	-0.01	-0.02	0.05	-0.01	0.01	0.02	0	-0.01	0.04	0.03	0	0.01
29.07.1996	0.04	0	-0.01	-0.07	-0.04	0.01	0.02	0.03	0.01	-0.04	-0.01	0.01	-0.01	-0.07	0.01	0.08	-0.01	0.05
05.08.1996	-0.02	0	0.04	0.04	-0.05	0.02	-0.02	0	0	0.08	-0.02	0	0.01	0.09	0.02	0.03	-0.01	-0.02
12.08.1996	-0.02	0.01	0	0.01	-0.03	0.02	0.01	-0.04	0	0.01	0.09	-0.01	0	-0.08	-0.04	-0.05	0	0.02
19.08.1996	0.01	-0.01	-0.03	-0.01	0.02	0.19	-0.01	0.04	0	0	0.03	0.01	0.04	-0.01	-0.01	0.09	0.01	0.02
26.08.1996	0	0	0	0	0	0	-0.01	0.02	0	0.01	-0.05	0	0.01	0.03	-0.01	-0.04	0.02	0.01
02.09.1996	-0.02	0	0.03	-0.02	0.01	0.06	0	0.02	-0.01	0	0.01	0.01	0	0.05	-0.03	0.02	0.01	0
09.09.1996	-0.01	-0.04	0	0.02	0	0.01	-0.01	-0.01	0.02	-0.04	0.02	0	0	0.01	-0.01	0.05	0	0.01
16.09.1996	0.01	0	0	-0.02	0.01	-0.08	-0.01	0.02	-0.02	-0.04	0	0.01	0	0	-0.01	0.02	0	0.01
23.09.1996	0.01	0	0	0.01	0	-0.01	-0.09	0.04	0.02	-0.02	0.03	-0.01	-0.01	-0.02	-0.02	0.02	-0.03	0.01
30.09.1996	0	0.04	0.02	0	0.01	-0.01	0.01	0.02	-0.01	0	0.05	0.01	0.03	0.04	0.05	0.04	0	0
07.10.1996	0.01	0	-0.01	-0.01	-0.01	0	0	0.02	0	0	0.08	0	-0.02	0.03	-0.05	0	0	0.01
14.10.1996	0.01	0.01	0	0.04	0.01	0	0.01	0.03	0.01	0	0.2	0	0	-0.04	0.01	0.04	0	0
21.10.1996	0	0	0	0.02	0	0.05	0.02	0.02	0.01	0	0.05	0.01	-0.01	0.08	-0.05	-0.01	0	0.01
28.10.1996	0.01	-0.05	-0.01	0	0.01	0.09	0.01	-0.01	-0.01	0.02	-0.08	-0.01	0.01	0.07	0	0	0	0.02
04.11.1996	0.01	0	0	-0.01	0	0.06	0.01	-0.03	0.01	0.02	-0.02	0	-0.01	-0.01	0	0.01	0	0
11.11.1996	0.02	0.01	0	0.03	0	0.01	0.02	0.1	0	-0.01	0.08	0	0	0.02	-0.03	0.17	-0.03	0.02
18.11.1996	0.06	-0.08	0.02	0.09	0.04	0.02	0.02	-0.01	0.01	-0.02	0.07	0	0.01	-0.01	0.01	0.02	0	0.07
25.11.1996	0.14	-0.05	0	0.35	0.2	0.11	0.35	0.11	0.02	-0.01	0.02	0.01	0.04	0.05	0.18	0.96	0.05	0.14
02.12.1996	-0.04	-0.01	0.04	-0.03	0.06	0.01	0.07	0.06	0.01	-0.15	0.05	0.02	0	0	0.13	-0.16	0	-0.06