ESTIMATING THE SYSTEMATIC RETURN RISK FOR THE NAIROBI STOCK EXCHANGE

BY

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DECLARATION

This Management Research Project is my original work and has not been presented for a degree in any other University.

Signed: ______________________ Date: 2/10/91

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This Management Research Project has been submitted for examination with my approval as University Supervisor.

Signed: ______________________ Date: 24-10-91

K.M. MWARANIA

DEDICATION

To Anne Kamene, who has stood by me all my life.

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ABSTRACT

The risk and return parameters of a stock market are of great interest not only to investors but to scholars and regulatory authorities among others. They give the "big" picture of the entire market and are therefore useful benchmarks against which to assess the optimality of returns from a security or a portfolio. Of equal importance is the effectiveness of diversification in the market. Portfolio holders are interested in the extend to which risk can be reduced through diversification.

This study sought to establish the market risk and return for the Nairobi Stock Exchange (NES) as well as assessing how effective the market diversifies unsystematic risk. Data on fourty-five companies quoted in the exchange was used to calculate the market parameters. Effectiveness was measured by establishing the proportion of unsystematic risk which was diversified away by the market. Comparison of the market risk and the theoretically expected market risk if full diversification of unsystematic risk had been acheived was done. Portfolio data for the sample companies was also calculated to establish how close it is to the market data. This test was largely intended to give credence (or nullify) the reliance on the market parameters calculated using the sample as good estimates of the full market of fifty seven companies.

The results indicated a market risk of four percent and a return of nearly six percent. With one-year Government of Kenya Treasury stocks having a coupon rate of 15% (July, 1991 issue), the full market return is thus about 21% which was consistent with the general market interest rates in the commercial sector. The market risk and risk premium calculated thus appeared to be good estimates of the total market parameters. Further, the market was found to diversify 94% of the total unsystematic risk and the portfolio beta was 0.9. This gave additional support to the conclusion that the market risk and return are therefore approximately equal 4% and 5.7% respectively.

CHAPTER 1: INTRODUCTION

1.1 Background

Sharpe (1981: 346-353) decomposes the risk of a risky asset into four components, viz: specific risk, industry risk, the common-factor risk and the market-related risk. The first three of these relate to the individual security and the general characteristics of the industry from which it is drawn and he refers to these as constituting the non-market risk element of a security. The market-related risk arises due to market-wide conditions and relates to more or less all the securities in the market.

Risk can also be classified as either systematic or unsystematic (Weston/Copeland 1986:414). The unsystematic risk can be reduced or even eliminated through diversification whereas the systematic risk cannot be diversified away. This is the same as the market-related risk (or the undivesifiable risk) and the non-market risk refers to the unsystematic or diversifiable component of the total risk.

Diversification can thus reduce the risk of a portfolio by reducing the unsystematic component of the total risk

(Elton/Gruber 1981: 278, Reilly 1979:210, Phillips/Ritchie 1983:199-200). The extend to which diversification will reduce risk in a portfolio depends on the relationship between the returns of the securities in the portfolio.

The return of a portfolio consisting of two securities i and j can be given by the linear combination of the individual securities's returns, weighted by the proportion of their holding within the portfolio. Thus;

$$R_p = W_i R_i + W_j R_j$$

where: R_p = portfolio return

W_i, W_j = proportion of securities i and j respectively held in the portfolio.

R_i, R_j = returns on securities i and j.

The risk, as measured by the variance of the returns of the above portfolio can also be calculated as;

$$\sigma_p^2 = E\left[W_i(R_{ik} - \bar{R}_i) + W_j(R_{jk} - \bar{R}_j)\right]^2$$

where: σ_p^2 = variance of portfolio returns

E = expectations operator, indicating the expected value.

R_{ik} = the k^{th} return on security i in a return distribution.

R_{jk} = the k^{th} return of security j in a return distribution.

$\bar{R}_i, \bar{R}_j$ = ex ante mean returns on securities i and j respectively.

This formula can be reduced mathematically to the form:

$$\sigma_p^2 = W_i\sigma_i^2 + W_j^2\sigma_j^2 + 2W_iW_j\,cov(i,j)$$

where $cov(i,j) = E(R_{ik} - \bar{R}_i)(R_{jk} - \bar{R}_j)$

(covariance between the returns of securities i and j).

For computational purposes, the covariance of returns is usually standardized by dividing it by the product of the standard deviations of the individual securities. This gives the correlation coefficient ,ρ_{ij} , without loss of, or change in the underlying properties of the covariance .

$$\rho_{ij} = \frac{cov(i,j)}{\sigma_i\sigma_j}$$

and therefore $cov(i,j) = \sigma_i\sigma_j\rho_{ij}$

The portfolio variance can hence be written as:

$$\sigma_p^2 = W_i\sigma_i^2 + W_j\sigma_j^2 + 2W_iW_j\sigma_i\sigma_j\rho_{ij}$$

The portfolio return and risk formulae given above, though in their simplest form, give the general basic tenets of portfolio theory and can be used to demonstrate the effects of diversification on portfolio risk.

As noted earlier, the extent to which diversification reduces portfolio risk depends on the relationship between the securities in the portfolio. Three extreme relationships are possible:

(a) where the securities are perfectly negatively correlated. In this case, the returns of security i behave in the exact opposite of those of security j. If the two securities are combined into a portfolio, then the combined risk can be reduced to zero.

(b) where the securities are perfectly positively correlated i.e $\rho_{ij} = +1$, the returns of i and j move in the same direction. It is possible to reduce risk but it cannot be reduced to zero.

(c) if correlation between i and j is zero, the securities are independent and movement in the returns of one security are not in any way related to those of the other. Variance (and hence risk) will be given by the linear combination of the individual variances and their weights. The effect of diversification will depend on the values of the individual risks.

The two-security portfolio given above can be generalized for N number of securities. The general expression for return and risk can then be given as:

$$R_p = \sum_{i=1}^{N} W_i \bar{R}_i$$

$$\sigma_p = \left[\sum_{i=1}^{N} W_i^2 \sigma_i^2 + \sum_{i=1}^{N} \sum_{\substack{j=1 \\ j \neq i}}^{N} W_i W_j \sigma_i \sigma_j \rho_{ij} \right]^{1/2}$$

As N becomes large, the contribution to the portfolio risk of the individual security's risk becomes very small (the first term in the above formula). The covariance, however, tends to the average covariance for the securities in the portfolio and hence in a very well diversified portfolio, covariance becomes the only important contributory factor to the total risk of the portfolio (Elton/Gruber 1981:35).

It follows from this that whereas the individual risk of a security can be diversified away, its covariance with the other securities in a portfolio cannot, and this is what is referred to as the market-related or systematic risk of a portfolio's returns.

The market offers the investor a risk premium in excess of the riskless rate of return for taking this undiversifiable risk. As pointed out by Weston and Copeland (1986:413),

> Because diversifiable risk can be eliminated at virtually no cost, the market will not offer a risk premium to avoid it

Elton/Gruber (1981:278) concur to this view and go further to add that,

> For very well diversified portfolios, nonsystematic risk tends to go to zero and the only relevant risk is systematic risk .....

If N (number of securities in a portfolio) is so large as to include all the securities in the market, then the portfolio becomes the market portfolio with return, R_M, and standard deviation, σ_M. This is the total portfolio held by all the investors in the market, each security held according to the proportion of its market value to the total market value of all the securities. Thus for security i, the weight will be:

$$W_i = \frac{\text{market value of the } i^{th} \text{ security}}{\text{market value of all securities in the market}}$$

It was shown above that systematic risk in a well diversified portfolio is equal to the covariance between the security's returns to those of the portfolio as a whole. Where the portfolio is the market portfolio, then systematic risk of security i can be written as:

$$\text{systematic risk} = Cov(i\ M)$$

where M is the market portfolio.

This systematic risk can be normalized (Reilly 1979:216) by dividing it by the market variance, i.e.

$$\text{Normalized systematic risk} = \frac{Cov(i\ M)}{\sigma_M^2}$$

and this is referred to as the beta(β_i) of a security or portfolio. Formally, the beta can hence be expressed as:

$$\beta_i = \frac{cov(i M)}{\sigma_M^2}$$

The expected return from a portfolio can be calculated, once its beta is known, using the Security Market Line equation (Reilly 1979:218, Phillips/Ritchie 1983:284, Elton/Gruber 1981:282) which defines the line along which efficient portfolios would lie.

The equation is usually given as:

$$E(R_j) = R_F + E\left[(R_M) - R_F\right]\beta_j$$

where E denotes expected value.

By expansion, this equation can also be rewritten as:

$$E(R_j) = \alpha_j + \beta_j \bar{R}_M$$

where α_j = a constant return independent of the market movements.

As noted earlier, the systematic risk of a portfolio can be expressed as:

$$\beta_p = \frac{Cov(p,M)}{\sigma_M^2}$$

If the portfolio is the market portfolio, then its beta is equal to 1 i.e.

$$\beta_M = \frac{Cov(M,M)}{\sigma_M^2} = 1$$

This relationship holds true because as a portfolio is diversified by increasing the number of securities therein, the unsystematic risk of each security tends to zero and its covariance with the portfolio tends to average covariance.

The systematic risk of a portfolio can also be computed as the weighted linear summation of the systematic risks of the securities in the portfolio.

$$\beta_p = \sum_{i=1}^{N} W_i \beta_i$$

For a fully diversified market portfolio,

$$\beta_M = 1$$

But $\beta_i = \dfrac{Cov(i, M)}{\sigma_M^2}$

Therefore,

$$\frac{Cov(M,M)}{\sigma_M^2} = \sum_{i=1}^{N} W_i \frac{Cov(i,M)}{\sigma_M^2}$$

and $$\sigma_M = \left[\sum_{i=1}^{N} W_i Cov(i,M) \right]^{1/2} \quad \text{.........equation 1}$$

Market risk has also been given as ,

$$\sigma_M^2 = \left[\sum_{i=1}^{N} W_i^2 \sigma_i^2 + \sum_{i=1}^{N} \sum_{j=1}^{N} W_i W_j \sigma_i \sigma_j \rho_{ij} \right]^{1/2} \quad \text{....equation 2}$$

$$i = j$$

If all unsystematic risk has been fully eliminated, then equations 1 and 2 would be equal. But where some unsystematic risk remains, then market risk calculated using equation 2 would be higher than that calculated using equation 1 because the first term in equation 2 would not reduce towards zero where unsystematic risk remains.

1.2 Statement of the problem

The risk of a portfolio is expected to fall as the number of securities in the portfolio is increased. If all the securities in the market are included into the portfolio, then the portfolio risk becomes the market risk.

The main problem which this study addresses is that of estimating the systematic risk for the Nairobi Stock Exchange (NSE). It will also attempt to establish whether or not diversification at the NSE eliminates fully the unsystematic risk of the market portfolio.

1.3 Objectives of the study

(a) The main objective of this study is to estimate the systematic risk, σ_M, for the NSE.

(b) To establish whether or not unsystematic risk is fully eliminated in the market portfolio, i.e. to investigate the effectiveness of diversification.

1.4 Importance of the study

Much attention has been given to the NSE in recent times not only by scholars and investors but by the Government as well. The Capital Markets Authority, established in 1989 to develop an organized capital market in Kenya, will rely to a substantial extend on the activities of the NSE for the success of its mission.

With the above in mind, the need for market parameters against which efficient investment policies (individual, corporate or Government) can be assessed is essential. This study will thus be of importance to:

(a) Investors.

Availability of the market risk and return values will enable investors to assess the efficiency of their portfolios and to alter them as necessary in order to optimize their returns. Those intending to undertake investment in securities will be able to determine the required return for the risk level associated with the security of interest. Determination of the required return should also enable investors to compute the price of a security which is justified by its return and risk compared to the market parameters.

(b) Scholars.

The study will enhance the overall understanding of the NSE. It will also enable further studies in areas where the knowledge of the market parameters is an essential input.

CHAPTER 2: LITERATURE REVIEW

2.1 Systematic Risk : Working Definition.

Systematic risk was earlier on defined as the undiversifiable risk of a security. This was expressed as:

$$\text{systematic risk} = \text{cov}(i\ M)$$

where: i = security i's returns (or a portfolio).

M = market portfolio returns.

In portfolio theory literature, the term "systematic risk" usually refers to the beta of a security or portfolio (Bowman 1979, Kim 1981 and Reilly 1979). The beta of a security is simply its covariance with the market divided by the market variance. This normalization standardizes the risk measure (with the market risk equal to 1) but the underlying risk remains the covariance between the security and the market.

Throughout this paper, covariance (or for one security the standard deviation) is used as the measure of systematic risk. This is consistent with the definition of systematic risk and can be transformed into beta by simply dividing it by the market variance.

2.2 Systematic risk and the Estimation risk

Input data into the construction of portfolios is obtained from past returns which are then used to predict future returns. These expected returns (mean returns) which are in turn used to determine the risk of a security suffer from the potential presence of estimation errors.

Most portfolio selection models such as the CAPM or APM assume that these estimation errors are independent and hence their expected value is zero. The expected returns are, as a result, treated as though they were "true" values rather than estimates. The possibility of the existence of estimation errors gives rise to the estimation risk i.e. the risk that results may be inaccurate due to ignoring the presence of estimation errors.

What is optimal in the absence of such an estimation risk is not necessarily optimal or even approximately optimal in the presence of estimation risk (Chen and Brown 1983). Ignoring the estimation risk can hence lead to suboptimal portfolios. Alexander and Resnick (1985) concur to this view, adding that,

> For the risk-averse investor, consideration of estimation risk is important in selecting an expected-utility-maximizing portfolio

However, they also point out that other researchers have found that when estimation risk is recognized, the location, rather than the composition of the efficient frontier changes.This implies that by ignoring the estimation risk, the composition of any efficient portfolio will not be affected.

2.3 Variance as a Measure of Risk

Since the Portfolio theory was originally postulated by Harry Markowitz in 1952, the Mean-Variance criterion has remained the most widely used basis for portfolio selection. The objective in portfolio selection is to maximize the investor's utility. The argument has been that the Mean-Variance (MV) rule is the appropriate basis for measuring risk and return for any risk-averse investor. Thus such an investor will prefer more to less return for any given risk level and less to more risk for any given level of return. It may be added that MV may have proved attractive due to its simplicity in application.

Arguments have, however, arose as to the appropriateness of the MV in portfolio selection. It has been pointed out (Hanoch and Levy, 1970) that the MV is sufficient for dominance only when the utility function is quadratic or the probability distributions of the resultant portfolios can be fully described by two parameters that are independent of each other. It is also valid when the returns are normally distributed (Bawa et al, 1979). Bawa et al (1979) found most returns to be lognormally distributed and thus the MV criterion may not, in practice, provide the best basis for portfolio selection.

It has also been considered that higher moments, which are also measures of risk, may lead to portfolio selections that differ from those selected using the MV rule alone. Studies on the direction of preference if higher momênts are considered (see Scott and Horvath, 1980) suggest that preferences using the first two moments are likely to be consistent with those arrived at using third and fourth moment (i.e. skewness and kurtosis). The first two moments can thus be considered adequate for purposes of portfolio selection. The researchers further noted that selection computations became rather complicated when higher moments are considered and hence the use of these higher moments would in all probabilities have little practical use.

Kroll,Levy and Markowitz (1984) compared portfolios constructed using MV against those determined using direct utility maximization. Their results indicated that for an infinite number of securities, results under the two approaches can be very different and thus concluded that MV is less reliable in portfolio selection where the number of securities is infinite. However, earlier work by Levy and Markowitz (1979) in which they found the two approaches to give the same or very similar results for a finite number of securities, was supported by the latter research. Where the number of securities under consideration is finite, the MV criterion can therefore be considered to be selecting portfolios that are at least approximately similar to those that could have been seletced using the direct utility maximization approach.

Meyer (1979) extended the argument further by contending that MV analysis gives efficient sets that are larger than necessary and hence suboptimal. He proposed new definitions that he utilizes to reduce the efficient sets. But it should be noted that the error arising due to having larger sets than needed may in fact not necessarily affect the individual portfolio selected.

2.4 Alternative Portfolio Selection Frameworks.

Due to the controversies that surround the MV model for portfolio selection, alternative frameworks have been sought that offer better results or apply in less restrictive conditions.One such criteria is stochastic dominance.

Stochastic dominance comprises of sets of inequalities involving functions of the probability distributions of the returns, that induce partial orderings of the set of probability distributions. These orderings produce an admissible set of choices under restrictions on the decision-maker's utility functions, that follow some prevalent and appealing modes of economic behaviour.(Further work on stochastic dominance can be found in Bawa (1982) and Vickson (1975)).This model is not only of limited practical application compared to the MV criterion, but also calls for complicated mathematics.

Time dominance consists of rules which provide partial ordering of temporal prospects, yielding an efficient set from which the ultimate choice will be made (Ekern, 1981). Temporal prospect here are simply decision alternatives distributed over time and inferior alternatives are eliminated using the NPV rule.

William Krasker (1982) developed a framework based on the minimax criterion.His model assumed that investors choose their portfolios such that they (the portfolios) have some minimax properties i.e. they have for instance some guaranteed level of some minimum utility. It turned out that this criterion gives portfolios that are, on the whole, identical to those selected under other criteria such as the MV .

Shalit and Yitzhaki (1984) developed a framework which combines characteristics of both the MV criterion and stochastic dominance.They used Mean-Gini (MG) instead of the traditional Mean-Variance to construct optimum portfolios. The method was found to incorporate the simplicity of MV and was considered more adequate for evaluating the variability of a prospect than the MV criterion.

As seen from the foregoing, the search the best portfolio selection criteria still goes on. So far, however, the MV criterion remains the most widely used portfolio selection method. One reason for this is its simplicity in application . It is based on only two measures (mean and variance) which are relatively easy to calculate.

Further, if we are willing to accept the concept of homogeneous investor behaviour, the effects of market conditions such as restrictions short sales will be similar e.g. where short sales are not allowed, the effect will be to increase the price of risky assets consistently (Jarrow, 1980). The MV method can then be considered as correctly reflecting the the best portfolios to maximize the investor's utility.

2.5 Market versus Accounting based Measures of Risk and Return

Broadly speaking, there are two main bases on which returns can be calculated. These are the market based measures and the accounting/financial based measures.The two measures, though different, have been found to be related. Bowman (1979) found that there is a theoretical correlation between some accounting measures and market measures. He concluded that accounting measures can thus be used for predicting future returns/risk. He however did not find evidence of correlation in the case of earnings and dividends.

In this study, market based measures will be used rather than accounting based measures because of the following reasons.

Accounting measures are rarely an indication of economic return (Aaker and Jacobson, 1987; Gitari, 1990). Return on investment, which the most widely used accounting measure, is considered to bear little relationship with economic activity. Its critics point to the problem of matching current income and historically priced investment base in the computation of the return on investment (ROI).

Although the above problem can be alleviated by adjusting all the accounting data for price changes, Current Cost accounting is still at a nascent stage and does not offer much assistance as far as agreed method of making such adjustments are concerned. In Kenya, experts usually do not agree on the level of inflation itself not to mention methods of adjusting for it in the accounting data. Accounting measures therefore may prove meaningless in this respect.At any rate accounting data is not as readily available as the market based measures which are collected at the Nairobi Stock Exchange. Indeed this alone is a strong enough case for the use of market based measures rather than accounting measures.

CHAPTER 3: RESEARCH DESIGN

3.1 Population.

The population for the study was all the companies quoted at the Nairobi Stock Exchange (NSE) as at 31st December 1988. The study covered only those companies that trade in equity stocks and therefore excluded those trading exclusively in preferred stocks.

3.2 Sampling Plan.

Companies included in the sample were those that had been listed at the NSE continuously for ten years to 31st December 1988. The study covered five years to December 1988 and where price information was not available for, say one year continuously, such a company was excluded from the sample. The five-year period from January, 1 1984 to December, 31 1988 had been chosen so as to fall within the period used in a previous study (Gitari, 1990). Gitari's study dealt with risk and return relationships at the NSE and his findings, especially that systematic risk is independent of the industry characteristics, was crucial in this study since portfolios were to be constructed on the basis of covariances without regard to the industry from which a particular security comes from. Assurance that this assumption holds was thus provided by ensuring that the period used falls within that of the previous study.There were 45 companies which satisfied the above sampling rules and hence formed the sample for the study.A list of the sample companies is shown in appendix 2.

3.3 Data Collection.

Data required was collected from the NSE in the form of secondary data. All data was collected on a quarterly basis for all 45 companies for 5 years, giving a total of 900 observation points.

3.4 Data Analysis.

Data collected was transformed into returns using the formula;

$$R_t = \frac{P_{t+1} - P_t + D_t}{P_t}$$

Where R_t = return for quarter t

P_{t+1}, P_t = prices of a security at the end and beginning of quarter t respectively

D_t = cash dividend for quarter t

Bid prices will be used in all cases and annual dividends will be converted into quarterly equivalents by dividing them by 4.

For each company, mean return and standard deviation were calculated using the Statgraphics Statistical Package which gives summary statistics for any given series of data points. These ~~will~~ thus became the inputs into the portfolio construction process (see appendix 2).

3.4.1 Systematic risk for the Market

As noted earlier, the mean-variance criterion was used in the calculation of the market risk. Starting with a two-security portfolio, additional securities were introduced, one at a time until all the securities have been included. Each security will be weighted by its market value in accordance with the definition of market risk (Weston and Copeland 1986: 414).Thus for security i, its weight, w, would be;

$$W_i = \frac{\text{market value of security } i}{\text{market value of all securities in the market}}$$

Market value was defined as the closing bid price of a security on 31[st] December 1988 (see appendix 2).

A custom-made computer program (written in BASIC language) was used for the calculation of the systematic risk for the market. The program thus calculated risk as:

$$\sigma_M = \left[\sum_{i=1}^{N} W_i^2 \sigma_i^2 + \sum_{\substack{i=1 \\ i \neq j}}^{N} \sum_{j=1}^{N} W_i W_j \sigma_i \sigma_j \rho_{ij} \right]^{1/2}$$

where $\rho_{ij} = \dfrac{cov(i\ j)}{\sigma_i \sigma_j}$

σ_i, σ_j = standard deviation of the returns of security i,j.

σ_M = systematic return risk for the market.

The market return associated with this risk level, R_M, was also calculated as;

$$R_M = \sum_{i=1}^{N} W_i \bar{R}_i$$

Although the nature of the curve traced in the portfolio risk/number-of-securities-held space by the addition of new securities depends on the order in which the new securities are introduced, the use of value weights ensured that there is one and only one risk/return point for a portfolio having all securities in the market. Further, any curve traced in the risk/number-of-securities space would terminate at this point. This point thus gave the market risk and return.The result is given together with the program in appendix 4.

3.4.2 Effectiveness of Diversification

The effectiveness of diversification can be assessed by considering the extend to which it reduces the portfolio risk. This assessment can be done in several ways:

(a) comparing the portfolio risk to the expected risk if all unsystematic risk had been diversified away,

(b) testing whether the weighted linear summation of the individual securities betas are approximately equal to the expected portfolio beta (for the market this is equal to 1)

(c) comparing the total risk to portfolio risk to establish how much of the unsystematic risk has been diversified away.

Each of these approaches was used in assessing the effectiveness of diversification using the market parameters as calculated under sub-section 3.4.1 above.

(a) the fully diversified portfolio

Market return has been given earlier on as:

$$\bar{R}_M = \sum_{i=1}^{N} W_i \bar{R}_i \quad \text{.......equation 3}$$

but $$\bar{R}_i = \frac{1}{n} \sum_{i=1}^{n} R_i \quad \text{.......equation 4}$$

where n = number of observed returns for security i.

N = number of securities in the market.

combining equations 3 and 4 ,

$$\bar{R}_M = \frac{1}{n} \sum_{i=1}^{N} \sum_{i=1}^{n} W_i R_i \quad \text{.......equation 5}$$

Using the results of equation 5, a series of market returns can be generated which correspond to the returns of individual securities. From this , market risk will then be calculated as,

$$\sigma_M = \left[\sum_{i=1}^{N} W_i \, Cov(i,M) \right]^{1/2}$$

This is the theoretically expected risk for a fully diversified portfolio and will be compared to risk calculated in sub-section 3.4.1 to establish the extend to which diversification reduced unsystematic risk for the NSE.

(b) Linear summation of betas

The beta of a portfolio can be obtained from the weighted linear summation of the individual security's betas. For the market portfolio therefore,

$$\beta_M = \sum_{i=1}^{N} W_i \beta_i \quad (= 1)$$

Gitari (Op. Cit.) calculated the betas of all the companies included in this study. These betas will be weighted and summed to establish how close the portfolio beta approximates the theoretical market beta of 1 (appendix 4).

(c) Proportion of unsystematic risk diversified

The difference between the two market risks compared in

(a) above represents the amount of unsystematic risk which remains undiversified in the market portfolio. The difference between total risk (linear summation of weighted risks of individual securities) and the "pure" systematic risk i.e. the covariance calculated in (a) above , is the total unsystematic risk. The proportion of unsystematic risk which has been diversified will be calculated as a measure of the overall effectiveness of diversification at the NSE.

CHAPTER 4 FINDINGS AND INTERPRETATION

4.1 Introduction.

This study set out to estimate the systematic risk for the NSE and to establish whether or not the market portfolio for the NSE is fully diversified i.e. whether all the unsystematic risk is eliminated in the market portfolio. The security returns used for the analysis are those shown in appendix 1. Price weights were used as surrogates for value weights in all the calculations. These weights were used because it would have been difficult to find value weights which are comparable for all the companies. As a result only prices could be relied upon to provide relatively comparable measures of value.

4.2 Systematic Risk for the NSE.

Table 1 shows the systematic risk and return for the NSE.

Table 1: Systematic risk and return for the NSE.

Market risk	3.95%
Market return	5.67%

The systematic (market) risk of about 4% indicates the excess risk undertaken by the investor when he/she invests in the market portfolio at the NSE. The associated return thus is the risk premium offered by the market for taking such a risk. This return is in excess of the risk-free rate of return which incorporates the real rate of return and inflation.

It is interesting to note that Gitari (Op. Cit.) calculated quarterly return/risk for the market and found these to be , on the average, about 6% and 3.6% respectively. Though he used averages rather than the portfolio selection formulae used herein, his results are very close to the findings of this study and this may indicates the stability of the market parameters. This result may , of course, be interpreted to mean that simple averages are good estimates of the market parameters for the NSE.

4.3 Effectiveness of Diversification at the NSE

4.3.1 Full diversification at the NSE

Table 2 gives the result of the theoretical fully diversified risk for the NSE. At full diversification, the individual unsystematic risk for each security tends to zero and hence only its covariance with the market would count for the purpose of determined the market risk.

Table 2: Fully Diversified Portfolio Risk

Market risk (fully diversified)	3.44%
Actual market risk	3.95%

This result indicates that the market risk, calculated using price weights to represent market value weights, is not fully diversified but leaves within the market portfolio some unsystematic risk.

This may mean either that the use of price weights fails to give a portfolio which is fully diversified or the market is not robust enough to diversify all the unsystematic risk.

4.3.2 Average beta for the NSE

Table 3: Estimated average beta for the portfolio

Average beta	0.901

Table 3 gives the average beta for the portfolio calculated from the security betas calculated by Gitari (Op. Cit.). The average of 0.9 is close enough to 1 to indicate that the portfolio is a good approximation of the market portfolio. Given that only 45 companies have been included in the portfolio out of a possible 55 or so companies quoted at the NSE, it is reasonable to expect the portfolio beta to be different from 1. However, all the actively traded stocks have been included and the intuitive expectation was that the average beta should be close to 1. A beta of 0.9 is considered close enough to justify the treatment of the 45-company portfolio as a good approximation of the market portfolio and thus the market risk and return calculated earlier are good estimates for the market parameters.

4.3.3 Total risk versus market risk

Table 4 gives the total risk for the market (both systematic and unsystematic) as well as the breakdown into the component parts.

Table 4: Analysis of total risk

systematic risk	3.44%
unsystematic risk	8.22%
total risk	11.66%

From earlier calculations, it was shown that the market risk (of 3.95%) is above the "pure" systematic risk of 3.44%. The amount of unsystematic in the market risk is therefore 0.51%. This implies a diversification effectiveness of 94%. Given all the findings in this chapter, it hence reasonable to expect that the market risk and return for the NSE are about 4% and 5.6% respectively.

CHAPTER 5. CONCLUSIONS, LIMITATIONS AND SUGGESTIONS FOR FURTHER RESEARCH

5.1 Conclusions.

The market risk for the NSE has been estimated at 4%. This is the excess risk undertaken by the market portfolio investor for which the reward, that is the related excess return is 5.7%.

This excess risk was found to include a very small portion of unsystematic risk which the market fails to diversify. However, the market was found to diversify 94% of the total unsystematic risk. This rate of diversification was considered very good given the size of the total market of only 57 securities and the fact that lack of a trading floor may affect the diversification effectiveness of the market by inhibiting trading activity level.

(a) This study utilized the Mean-Variance model for determining the market risk and return. As discussed in chapter 2, the Mean-Variance criterion has been questioned in recent times and other criteria, including stochastic dominance, time dominance , Mean-Gini and the Minimax model have been put forward as alternatives. The results obtained may thus be

inferior to those that may have been obtained had a another framework of analysis been adopted.

(b) Price weights were used as surrogates for market value weights in calculating the market portfolio. Market price, in reality, need not necessarily reflect the value of a security as price is determined by among others the forces of demand and supply which are based on future expectations whereas value is based largely on the underlying asset base and its strength.. The results are therefore dependent directly on the aptness of this surrogation.

(c) Due to lack of price data, only 45 companies were used in the analysis rather than the 57 quoted companies. Since the market portfolio is defined as that containing all the securities in the market, this reduction in the number of companies used, though necessitated by lack of data, could have affected the calculated risk and return for the market.

5.3 Suggestions for further research

This study was the first to look at the risk and return for NSE as a whole. Being a pioneer research paper, it leaves several issues that can be addressed to in future research work.

The use of price weights to surrogate market values has been noted as a limitation to the study.It would be interesting to estimate the market risk and return using other surrogate measures such as the net asset value per share, to find out whether these offer a better market portfolio.

Given the recent arguments against the Mean-Variance replicated using a different criteria to establish whether a better method for portfolio selection can be obtained.

If price data were to be available for all the companies quoted at the NSE, this study can be extended to include all the companies so as to calculate the true market risk and return.

APPENDIX 1
QUARTERLY RETURNS FOR SAMPLE COMPANIES

YEAR	QUARTER	x1	x2	x3	x4	x5	x6
1984	1	0.000	0.302	0.057	-0.424	0.073	-0.058
	2	0.000	-0.212	0.028	0.000	0.242	-0.077
	3	0.304	-0.210	0.022	-0.015	-0.012	0.156
	4	-0.211	0.016	-0.009	0.058	0.131	0.000
1985	1	0.046	-0.292	0.067	-0.062	0.132	0.017
	2	-0.022	0.115	0.004	0.044	0.128	0.117
	3	0.100	0.219	-0.490	-0.030	-0.034	-0.135
	4	0.287	0.225	0.374	0.000	-0.075	0.051
1986	1	0.000	0.013	0.069	-0.500	0.068	-0.377
	2	-0.077	0.041	-0.032	0.170	0.192	0.105
	3	-0.010	-0.542	0.047	0.000	0.062	-0.076
	4	-0.160	0.191	-0.058	0.185	0.059	0.314
1987	1	0.000	0.062	0.119	0.058	0.121	0.122
	2	0.000	0.212	0.113	0.198	0.041	0.041
	3	0.000	0.120	0.030	0.157	-0.024	0.271
	4	0.000	-0.030	0.096	-0.020	0.040	0.107
1988	1	0.083	-0.110	-0.007	-0.351	0.090	0.020
	2	0.429	0.126	-0.015	0.026	0.181	-0.040
	3	0.103	-0.140	0.029	-0.118	0.020	0.201
	4	0.154	0.039	0.026	-0.116	0.083	0.072

YEAR	QUARTER	x7	x8	x9	x10	x11	x12
1984	1	0.086	0.457	0.102	0.100	-0.129	0.044
	2	0.067	0.067	0.057	-0.030	0.045	0.000
	3	-0.044	0.038	-0.038	0.125	-0.144	-0.052
	4	0.116	0.025	0.292	-0.031	0.059	0.093
1985	1	0.010	0.024	0.188	0.096	0.030	-0.489
	2	0.144	0.000	-0.073	0.060	0.145	0.224
	3	0.014	0.000	-0.040	0.034	-0.219	-0.041
	4	-0.049	0.035	0.035	0.081	0.041	0.311
1986	1	0.038	-0.042	0.185	0.044	0.114	-0.215
	2	0.010	0.072	-0.008	0.037	0.105	-0.161
	3	-0.010	-0.017	0.193	0.064	0.075	0.177
	4	0.283	0.250	-0.125	0.087	0.055	0.039
1987	1	0.040	0.075	0.233	0.058	0.069	0.091
	2	0.069	0.145	0.176	0.153	0.007	0.114
	3	0.003	-0.239	0.039	0.344	0.048	0.074
	4	0.063	0.125	-0.185	-0.018	0.050	0.053
1988	1	0.016	0.041	0.365	0.010	0.115	-0.009
	2	0.084	-0.696	-0.391	-0.048	-0.361	-0.017
	3	-0.037	0.021	-0.020	0.060	0.154	0.057
	4	0.032	-0.127	-0.058	0.001	-0.010	0.021

1984	1	0.048	0.078	-0.062	0.029	-0.178	-0.168
	2	0.071	0.313	0.072	0.076	0.209	0.104
	3	0.000	0.313	0.045	0.018	-0.303	0.127
	4	-0.255	0.518	-0.080	0.055	0.154	-0.007
1985	1	0.100	0.154	0.055	0.084	-0.130	0.154
	2	0.048	0.104	0.120	0.105	0.020	0.050
	3	0.000	0.104	0.000	0.008	0.020	0.142
	4	0.095	0.302	-0.038	0.184	0.020	-0.008
1986	1	-0.105	-0.007	0.059	0.061	0.031	0.011
	2	0.019	0.020	-0.288	0.251	-0.615	0.006
	3	0.061	0.081	-0.082	-0.064	0.368	0.028
	4	0.050	0.128	-0.017	0.050	0.122	0.079
1987	1	-0.263	0.017	0.048	0.054	0.133	0.098
	2	0.174	0.017	-0.016	0.081	-0.083	-0.053
	3	-0.065	-0.264	0.101	-0.006	0.232	0.119
	4	-0.350	0.087	-0.131	0.121	0.209	-0.178
1988	1	-0.400	0.033	-0.386	0.017	0.169	0.064
	2	0.385	0.007	0.200	0.032	0.196	0.123
	3	0.313	-0.131	-0.038	-0.016	-0.208	0.194
	4	-0.013	-0.001	-0.089	0.039	0.092	0.051

YEAR	QUARTER	x19	x20	x21	x22	x23	x24
1984	1	-0.183	-0.077	0.382	0.103	0.026	0.271
	2	0.224	-0.182	-0.359	0.026	-0.027	0.098
	3	0.031	-0.100	0.075	-0.490	0.063	-0.083
	4	-0.043	0.138	0.397	0.320	-0.231	-0.201
1985	1	-0.065	-0.043	-0.196	0.019	-0.042	0.135
	2	0.399	0.168	0.020	0.002	0.324	0.125
	3	0.004	-0.024	0.040	-0.060	0.029	-0.020
	4	0.043	0.242	0.262	0.071	0.132	-0.010
1986	1	-0.025	0.211	0.241	0.043	0.344	0.082
	2	0.061	-0.070	-0.341	0.103	0.034	0.038
	3	0.145	0.431	0.008	0.150	-0.048	0.054
	4	0.014	-0.119	0.067	-0.094	-0.098	-0.013
1987	1	0.064	0.060	-0.279	-0.143	0.250	0.038
	2	0.178	0.033	-0.170	-0.050	0.043	0.077
	3	0.065	0.033	0.275	-0.429	0.093	-0.057
	4	0.126	0.326	0.070	0.103	-0.048	0.142
1988	1	0.186	-0.125	-0.024	-0.200	0.181	0.063
	2	0.274	0.053	0.082	0.103	0.184	0.063
	3	0.020	-0.013	-0.478	0.076	0.200	0.087
	4	0.152	0.060	-0.087	0.021	0.129	0.089

1984	1	0.000	0.119	0.098	0.042	0.043	0.083
	2	0.000	0.086	-0.055	0.179	0.105	0.313
	3	0.000	-0.020	-0.007	-0.350	-0.026	-0.044
	4	-0.304	0.182	0.134	0.258	0.119	0.384
1985	1	-0.438	0.072	0.190	0.285	0.073	-0.336
	2	0.000	0.070	-0.144	0.197	0.147	0.043
	3	0.000	-0.018	-0.012	0.322	-0.081	0.105
	4	0.000	0.150	0.236	-0.300	0.111	0.300
1986	1	0.000	0.116	-0.057	0.050	0.092	-0.088
	2	0.000	0.056	0.028	0.050	0.064	0.016
	3	0.000	-0.050	0.068	-0.118	0.099	-0.098
	4	0.000	0.243	-0.025	0.360	0.048	0.322
1987	1	0.000	-0.001	0.036	0.040	0.478	0.228
	2	0.000	0.095	0.091	0.040	0.196	-0.056
	3	-0.067	-0.005	0.047	0.127	0.217	0.034
	4	0.000	0.310	0.113	-0.019	-0.108	-0.059
1988	1	0.000	0.040	0.127	0.107	0.082	-0.223
	2	0.000	0.054	-0.011	0.069	0.161	-0.080
	3	0.000	0.050	-0.115	-0.160	-0.046	-0.117
	4	0.000	0.114	0.028	-0.001	0.022	-0.120

YEAR	QUARTER	x31	x32	x33	x34	x35	x36
1984	1	0.031	-0.005	0.381	0.017	-0.010	-0.305
	2	0.031	-0.025	0.332	0.288	-0.056	0.427
	3	0.031	0.114	0.072	-0.069	0.183	0.072
	4	0.225	0.101	0.343	-0.045	0.147	0.357
1985	1	0.353	0.010	-0.170	0.175	0.277	-0.007
	2	-0.225	0.111	0.300	-0.036	0.190	-0.283
	3	0.350	0.071	0.500	-0.016	0.053	0.114
	4	-0.180	0.145	0.135	-0.407	0.239	0.078
1986	1	0.084	0.062	0.413	-0.007	0.089	0.129
	2	0.022	0.127	0.200	0.007	0.013	0.086
	3	-0.204	-0.013	0.012	-0.239	0.079	0.219
	4	0.027	0.212	0.235	0.180	0.053	0.089
1987	1	0.031	0.089	0.141	0.035	0.144	-0.044
	2	0.031	0.132	0.225	0.030	0.048	0.210
	3	0.100	-0.002	0.005	0.212	0.358	0.085
	4	0.029	-0.034	0.327	0.119	0.056	0.153
1988	1	0.029	0.002	0.159	-0.279	0.381	0.331
	2	0.029	0.113	0.159	0.071	0.148	0.059
	3	0.056	0.082	0.159	0.361	0.318	-0.200
	4	0.035	0.041	0.201	0.068	0.226	0.086

YEAR	QUARTER	x37	x38	x39	x40	x41	x42
1984	1	0.046	0.000	0.321	0.111	-0.208	0.222
	2	0.048	-0.015	-0.049	-0.242	0.057	0.208
	3	-0.097	0.300	-0.141	0.212	0.084	-0.044
	4	-0.025	-0.100	0.026	0.012	-0.088	0.198
1985	1	-0.042	0.013	-0.048	0.020	0.186	0.147
	2	0.198	0.013	-0.445	-0.072	0.046	0.101
	3	-0.085	0.122	0.315	0.022	0.043	-0.073
	4	0.069	0.011	-0.120	0.044	-0.098	0.087
1986	1	0.128	-0.084	0.194	0.068	0.033	0.125
	2	0.075	-0.186	-0.028	-0.022	0.126	0.038
	3	0.026	-0.077	-0.024	0.059	-0.013	0.057
	4	0.045	0.071	0.056	-0.049	0.097	-0.087
1987	1	0.085	0.025	0.230	0.047	0.065	0.122
	2	0.118	-0.241	-0.347	0.162	-0.030	0.077
	3	0.107	0.032	0.082	0.228	0.184	0.084
	4	0.052	0.032	0.160	0.178	0.237	-0.105
1988	1	-0.410	0.117	0.035	0.028	0.245	0.135
	2	0.117	0.356	-0.030	-0.293	-0.078	-0.015
	3	0.001	-0.467	0.060	0.398	-0.274	0.109
	4	-0.060	0.009	0.056	0.078	0.033	0.031

YEAR	QUARTER	x43	x44	x45
1984	1	-0.141	0.000	0.146
	2	0.041	0.130	-0.034
	3	0.041	-0.150	0.059
	4	0.121	0.000	0.030
1985	1	0.037	0.333	0.060
	2	0.037	0.000	0.032
	3	-0.050	0.000	0.032
	4	0.267	0.000	-0.034
1986	1	-0.200	0.000	0.079
	2	0.000	-0.500	0.088
	3	-0.200	0.000	0.144
	4	0.138	-0.047	-0.136
1987	1	0.033	0.000	0.044
	2	0.000	0.000	0.086
	3	-0.250	0.000	0.310
	4	-0.116	0.000	0.009
1988	1	0.085	0.000	0.027
	2	-0.068	0.000	0.027
	3	-0.100	0.000	0.100
	4	-0.050	0.000	0.041

Note on appendix 1:

The company codes XI through X45 refer to listed companies as per appendix 2. Thus for instance the company coded XI in appendix 1 refers to company number 1 in appendix 2 i.e. African Tours and Hotels Ltd. and so forth.

APPENDIX 2. List of companies and weights

COMPANY	WEIGHT
1. AFRICAN TOURS AND HOTELS LTD	0.0085
2. A. BAUMANN AND CO. LTD	0.0059
3. B.A.T (K) LTD	0.0719
4. BAMBURI PORTLAND CEMENT CO. LTD	0.0063
5. BROOKE BOND LIEBIG KENYA	0.0719
6. CAR & GENERAL (K) LTD	0.0114
7. CARBACID INVESTMENTS LTD	0.0253
8. CITY BREWERY INVESTMENT LTD	0.0055
9. CONSOLIDATED HOLDINGS LTD	0.0055
10. CMC HOLDINGS LTD	0.0253
11. CREDIT FINANCE CORPORATION LTD	0.0253
12. DIAMOND TRUST OF KENYA LTD	0.0456
13. DUNLOP KENYA LTD	0.0072
14. EAAGADS LTD	0.0063
15. E.A. BAG AND CORDAGE CO. LTD	0.0034
16. KENYA BREWERIES LTD	0.0465
17. E.A. CABLES LTD	0.0194
18. E.A. OXYGEN LTD	0.0203
19. E.A. PACKAGING INDUSTRIES LTD	0.0313

20. E.A. PORTLAND CEMENT CO. LTD	0.0101
21. E.A. ROAD SERVICES LTD	0.0017
22. ELLIOTS BAKERIES LTD	0.0042
23. EXPRESS KENYA LTD	0.0169
24. GEORGE WILLIAMSON KENYA LTD	0.0236
25. HUTCHING BIEMER LTD	0.0085
26. ICDC INVESTMENT CO. LTD	0.0317
27. KAKUZI LTD	0.0304
28. KAPCHORUA TEA CO. LTD	0.0211
29. KENYA NATIONAL MILL LTD	0.0161
30. KENYA OIL CO. LTD	0.0051
31. KENYA ORCHIDS LTD	0.0072
32. KENYA POWER AND LIGHTING CO. LTD	0.0558
33. LIMURU TEA CO. LTD	0.0169
34. MARSHALLS (E.A) LTD	0.0186
35. MOTOR MART AND EXCHANGE LTD	0.0338
36. NATIONAL PRINTERS AND PUBLISHERS LTD	0.0186
37. NATIONAL INDUSTRIAL CREDIT (E.A) LTD	0.0312
38. OL PEJETA RANCHING LTD	0.0355
39. PAN AFRICAN INSURANCE CO. LTD	0.0135

40. PEARL DRY CLEANERS LTD	0.0101
41. PHLIPS,HARRISONS AND CROSFIELD LTD	0.0317
42. SASINI TEA AND COFFEE	0.0494
43. SOFAR INVESTMENTS LTD	0.0089
44. THETA GROUP LTD	0.0059
45. TIMSALES	0.0507

rage Betas

COMPANY	BETA
1. AFRICAN TOURS AND HOTELS LTD	-1.0158
2. A. BAUMAN AND CO. LTD	2.144
3. B.A.T (K) LTD	1.100
4. BAMBURI PORTLAND CEMENT CO. LTD	2.012
5. BROOKE BOND LIEBIG KENYA	1.8739
6. CAR & GENERAL (K) LTD	2.9174
7. CARBACID INVESTMENTS LTD	0.0143
8. CITY BREWERY INVESTMENT LTD	-0.502
9. CONSOLIDATED HOLDINGS LTD	2.036
10. CMC HOLDINGS LTD	0.4587
11. CREDIT FINANCE CORPORATION LTD	0.6258
12. DIAMOND TRUST OF KENYA LTD	0.685
13. DUNLOP KENYA LTD	-1.3646
14. EAAGADS LTD	0.604
15. E.A. BAG AND CORDAGE CO. LTD	0.5315
16. KENYA BREWERIES LTD	0.9309
17. E.A. CABLES LTD	0.855
18. E.A. OXYGEN LTD	1.362
19. E.A. PACKAGING INDUSTRIES LTD	1.208

20. E.A. PORTLAND CEMENT CO. LTD	2.907
21. E.A. ROAD SERVICES LTD	-0.7809
22. ELLIOTS BAKERIES LTD	1.9972
23. EXPRESS KENYA LTD	0.4933
24. GEORGE WILLIAMSON KENYA LTD	0.689
25. HUTCHING BIEMER LTD	-0.3108
26. ICDC INVESTMENT CO. LTD	1.14
27. KAKUZI LTD	1.34
28. KAPCHORUS TEA CO. LTD	2.42
29. KENYA NATIONAL MILL LTD	0.7912
30. KENYA OIL CO. LTD	2.842
31. KENYA ORCHIDS LTD	-0.3095
32. KENYA POWER AND LIGHTING CO. LTD	1.00
33. LIMURU TEA CO. LTD	1.069
34. MARSHALLS (E.A) LTD	1.246
35. MOTOR MART AND EXCHANGE LTD	1.456
36. NATIONAL PRINTERS AND PUBLISHERS LTD	2.00
37. NATIONAL INDUSTRIAL CREDIT (E.A) LTD	0.7966
38. OL PEJETA RANCHING LTD	-0.7303
39. PAN AFRICAN INSURANCE CO. LTD	-0.5495

40. PEARL DRY CLEANERS LTD	0.728
41. PHLIPS,HARRISONS AND CROSFIELD LTD	-0.268
42. SASINI TEA AND COFFEE	0.0195
43. SOFAR INVESTMENTS LTD	0.6983
44. THETA GROUP LTD	-0.57
45. TIMSALES	-0.619

APPENDIX 4: BASIC PROGRAM

```
5 REM PRG TO CALCULATE MARKET RISK AND RETURN
6 REM VAR. DFNS: A$ =CO. CODE, A1= RETURN, A2= RISK, B=WEIGHT
7 REM C=RETURNS MATRIX FOR COVARIANCE CALCULATIONS
8 REM LINE 10-80 INITIALIZE VARIABLES AND SETS ARRAYS
10 DIM A$(45),A1(45),A2(45),B(45),C(45,21),M(1,21),Q(45)
15 FOR D=1 TO 45
20 READ A$(D),A1(D),A2(D)
25 NEXT D
30 B1=0
35 FOR E=1 TO 45
40 READ B(E)
45 B1=B1+B(E)
50 NEXT E
55 FOR F=1 TO 45
60 FOR G=1 TO 21
65 READ C(F,G)
70 NEXT G`
75 NEXT F
77 FOR R=1 TO 45
78 READ Q(R)
79 NEXT R
80 T=U=V=W=X=Y=S10=S30=0
85 FOR I=1 TO 45
90 FOR J=1 TO 45
95 IF I=J THEN 125
100 GOSUB 600
105 X=X + ((B(I)*B(J))/(B1)^2)*(A2(I)*A2(J))*W
110 Y=Y + ((B(I)/B1)^2*(A2(I)^2)
115 Z=(X+Y)^1/2
120 NEXT J
125 V=V+ (B(I)/B1*A1(I)
130 NEXT I
133 PRINT "MARKET PARAMETERS"
134 PRINT "-----------------------------------"
135 PRINT "MARKET RISK =",TAB(30);Z*100"%"
140 PRINT "MARKET RETURN =",TAB(30);V*100"%"
141 PRINT "-----------------------------------"
145 PRINT
150 N=S1=T=T1=N1=0
```

```
155 FOR I =2 TO 21
160 H=0
170 FOR J=1 TO 45
180 H=H+ (C(J,I)*B(J)/(B1)
190 NEXT J
200 M(1,I) =H
210 N1=N1 +M(1,I)
215 N=N1/(20*25)
220 NEXT I
230 FOR K=1 TO 45
240 FOR L=2 TO 21
250 T1=T1 + ((C(K,L) -A1(K)*(M(!,L)-N)/400)
260 NEXT L
270 T=T +T1
280 NEXT K
300 S1=(X)^1/2
310 PRINT "FULLY DIVERSIFIED MARKET PORTFOLIO"
320 PRINT "-----------------------------------"
330 PRINT "MARKET RISK =",TAB(30);S1*100"%"
340 PRINT "-----------------------------------"
350 GOTO 650
600 W1=0
605 FOR K=2 TO 21
610 W1=W1 + ((C(I,K) - A1(I))*(C(J,K) - A1(J)))/400
615 NEXT K
620 W=W1/(A2(I)*A2(J)
625 RETURN
650 U=0
655 FOR O=1 TO 45
660 U=U +Q(O)*(B(O)/B1)
665 NEXT O
670 PRINT "AVERAGE BETA FOR COMPANIES =",U
900 END
```

NOTE: Data for the various computations is as shown in appendix 1 for returns matrix, appendix 5 for risk and returns and appendix 3 for average beta. The weights used are in appendix 2.

Results of the progran run:

Market risk = 3.954092%

Market return = 5.670652%

Fully diversified risk = 3.437979%

Average beta of companies = .9007274

APPENDIX 5. Rsik and return for sample companies

COMPANY	RETURN	RISK
1. AFRICAN TOURS AND HOTELS LTD	.0153	.1515
2. A. BAUMAN AND CO. LTD	.0073	.2080
3. B.A.T (K) LTD	.0235	.1501
4. BAMBURI PORTLAND CEMENT CO. LTD	-.037	.1912
5. BROOKE BOND LIEBIG KENYA	.0412	.1523
6. CAR & GENERAL (K) LTD	.0468	.0757
7. CARBACID INVESTMENTS LTD	.0127	.2159
8. CITY BREWERY INVESTMENT LTD	.0464	.1775
9. CONSOLIDATED HOLDINGS LTD	.0644	.0831
10. CMC HOLDINGS LTD	.0125	.1300
11. CREDIT FINANCE CORPORATION LTD	.0318	.1653
12. DIAMOND TRUST OF KENYA LTD	-.0044	.1978
13. DUNLOP KENYA LTD	.0937	.1703
14. EAAGADS LTD	-.0263	.1346
15. E.A. BAG AND CORDAGE CO. LTD	.0589	.0699
16. KENYA BREWERIES LTD	.0229	.2258
17. E.A. CABLES LTD	.0468	.0980
18. E.A. OXYGEN LTD	.0759	.0801
19. E.A. PACKAGING INDUSTRIES LTD	.0835	.1312

20. E.A. PORTLAND CEMENT CO. LTD	.0501	.1607
21. E.A. ROAD SERVICES LTD	-.0007	.2467
22. ELLIOTS BAKERIES LTD	-.0163	.1886
23. EXPRESS KENYA LTD	.0769	.1442
24. GEORGE WILLIAMSON KENYA LTD	.0489	.0979
25. HUTCHING BIEMER LTD	-.0404	.1161
26. ICDC INVESTMENT CO. LTD	.0832	.0897
27. KAKUZI LTD	.0385	.0967
28. KAPCHORUS TEA CO. LTD	.0589	.1888
29. KENYA NATIONAL MILL LTD	.0898	.1252
30. KENYA OIL CO. LTD	.0254	.1878
31. KENYA ORCHIDS LTD	.0443	.1475
32. KENYA POWER AND LIGHTING CO. LTD	.0666	.0674
33. LIMURU TEA CO. LTD	.2065	.1577
34. MARSHALLS (E.A) LTD	.0233	.1843
35. MOTOR MART AND EXCHANGE LTD	.1468	.1237
36. NATIONAL PRINTERS AND PUBLISHERS LTD	.0828	.1902
37. NATIONAL INDUSTRIAL CREDIT (E.A) LTD	.0198	.1267
38. OL PEJETA RANCHING LTD	-.0034	.1758
39. PAN AFRICAN INSURANCE CO. LTD	.0151	.1908

40. PEARL DRY CLEANERS LTD	.0495	.1538
41. PHLIPS,HARRISONS AND CROSFIELD LTD	.0324	.1362
42. SASINI TEA AND COFFEE	.0708	.0927
43. SOFAR INVESTMENTS LTD	-.0188	.1273
44. THETA GROUP LTD	-.0117	.1451
45. TIMSALES	.0555	.0870

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