

**ANALYSING THE EFFECT OF TREASURY BILL RATES
ON STOCK MARKET RETURNS USING GARCH MODEL**

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ABSTRACT

This paper examines the relationship between the returns of ordinary shares listed at the Nairobi Stock Exchange (NSE) and the Treasury Bills Rate using GARCH Analysis. Existing studies in Kenya on the relationship of factors affecting the returns of assets in the NSE have used various methods, mostly Ordinary Least Squares (OLS) Regression and have yielded inconclusive results. This study recognizes the unique characteristic of financial series data that makes common analysis techniques like OLS regression unsuitable for generating effective forecast models. The study systematically examines the returns of the various market segment returns within the NSE for these characteristics so as to build a basis for using GARCH analysis. Finally, it compares the results obtained using OLS regression with the results obtained using GARCH analysis techniques.

The study concluded that in keeping with theory, Treasury Bill Rates have a significant impact on the asset returns of the various market segments, the NSE – 20 Share Price Index and All market returns as a whole. The behaviour of the returns of assets on the NSE can be better explained by considering the volatility of previous periods. The study found that GARCH analysis gives a better explanation for the relationship between Treasury Bill Rates and asset returns than OLS regression in every market segment. Furthermore, the explanatory power becomes stronger as we consider the effect of previous variances on the current observations.

INTRODUCTION

Over the years financial analysts and investors have been concerned about the impact of Treasury bills rate on the behavior of stock returns. Institutions that issue Treasury bills and stocks are competing for investors' funds. Correct choice ensures that the investors are able to reduce their risk and enhance returns by recognizing the underlying direction of the markets and taking positions accordingly. This is in line with the assumption that rational investors only assume risk if they will be adequately compensated. Therefore investors have to rank assets on a risk- return perspective then select the assets to invest in according to their individual risk preferences as noted by Markowitz (1952) in his mean variance paradigm.

Treasury bills are the least risky, Elton and Gruber (1995), but play a special role in financial theory because they have no risk of default in addition to very short term maturities. Ordinary shares issued by private entities represent an ownership claim on the earnings and assets of the firm that issued them, Elton and Gruber (1995). Even with the limited liability that ordinary shares come with, the residual nature of claims (on a firm's assets and earnings) accruing to shareholders, this class of investment is considered the riskiest. However money to productive sector in the form of subscription for stocks in corporations could contribute much more desired economic growth than money invested in treasury bills.

The interest on Treasury bills is generally viewed as the representative money market rate. For this reason Treasury bill interest rates are typically used as the index rate for variable rate financial contracts. In particular, the spread between private money rates and Treasury bill interest rates is used as a measure of the default risk premium on private securities. It is therefore not surprising that the Treasury bill interest rate is generally used to test various hypotheses about the effect of such economic variables as the rate of inflation or the money supply on the general level of short term interest rates, Cook and Lawyer (1983). Furthermore Treasury bill interest rates are used to test hypotheses about the determinants of money market yield curves. Despite this central role accorded to Treasury bill interest rates, they frequently diverge greatly from other high risk assets of comparable maturity. Furthermore, this differential is subject to abrupt change, Cook and Lawyer, (1983).

Studies on financial markets and specifically those on the pricing of assets, model the relationship between competing assets such as private stock returns and Treasury Bills using linear regression techniques. However, a significant re-evaluation of statistical basis of econometric models starting in the 1980s suggests that there is a need to balance theory with statistical analysis (Banerjee, Dolado, Galbraith and Hendry, 1993). Econometric modeling basis has expanded from assumption of stationary to include integrated processes. The effect of the expansion is continuing and is having enormous influence on choice of model forms, statistical inference and interpretation of a number of traditional concepts such as collinearity, forecasting and measurement errors.

Stationary time series data showing fluctuating volatility and, in particular, financial return series have provided the impetus for the study of a whole series of econometric time series models that may be grouped under the general heading of GARCH (Generalized Auto Regressive Conditionally Heteroskedastic) models, Engle (1982), Bollerslev, Chou, and Kroner, (1992) and Shephard, (1996). The hidden variable volatility depends parametrically on lagged values of the process and lagged values of volatility.

GARCH modeling, which builds on advances in the understanding and modeling of volatility in the last decade, has become an important econometric technique. GARCH takes into account excess kurtosis and volatility clustering, two important characteristics of financial time series. It provides accurate forecasts of variances and covariances of asset returns through its ability to model time-varying conditional variances. As a consequence, GARCH models have been applied successfully to such diverse fields as risk management, portfolio management and asset allocation, option pricing, foreign exchange, and the term structure of interest rates. Highly significant GARCH effects have been found in equity markets, not only for individual stocks, but for stock portfolios and indices, and equity futures markets as well, Bollerslev, Chou, Kroner, (1992). These effects are important in such areas as value-at-risk (VaR) and other risk management applications that concern the efficient.

This study examines the relationship between Treasury Bills Rate and the return of assets on the Nairobi Stock Exchange using GARCH analysis. The study also carries out OLS linear regression and compares their forecasting capability to those obtained through GARCH analysis.

STATEMENT OF THE PROBLEM, OBJECTIVE OF THE STUDY, JUSTIFICATION OF THE STUDY

In Kenya the bearish nature of the stock market before 2002 has been blamed on the excessive borrowing by the Kenya Government. Jiwaji (2004), writing for G21 notes, "Kenyans have paid and continue to pay a very high price, both in budgetary and economic costs, for the financial indiscipline of the 1990s which was characterized by high fiscal deficits, excessive domestic borrowing..." If the preceding assertion holds, then an association exists between government borrowing and stock market performance and must be visible and capable of adversely affecting the levels of private investment.

Economist Valentino Piana, (2002) tells us that a large and abrupt increase in general interest rates can have devastating effects on crucial real variables, exerting a depressing pressure on Gross Domestic Product (GDP) and the economy at large. Macroeconomic theory suggests it is through interest rates that monetary policy actions are transmitted to the economy, Roley and Sellon (1995). Furthermore, the CBK 15th Monetary Policy Statement, December (2004), notes that when the the money supply increases, short-term rates drop, which stimulates activity in interest-sensitive sectors. Studies of the determinants of output movements conducted since the early 1980's found that when interest rates are considered, the monetary aggregates lose most of their explanatory power, suggesting that interest rates contain important information about future output, (Sims, 1980). However of concern to us is whether the relationship between the returns of assets on the NSE and treasury bills rate is large enough to be relied on by investors as an investment signal.

Studies on financial time series confirm that financial series exhibit increased conditional variance and the use of Ordinary Least Squares Linear Regression may not be sufficient to fully accommodate these variances and incorporate their impact into current forecast models. It therefore becomes necessary to apply competing modeling approaches on NSE financial time series data.

The first objective of this study is to examine the extent of the relationship between the Treasury Bills rate and the returns of stocks traded on the Nairobi Stock Exchange. The second objective is to compare Ordinary Least Square (OLS) regression analysis and GARCH

analysis in predicting the returns of assets on the NSE using Treasury Bills rate as the independent variable.

Portfolio managers can use this study to counter-check their investment recommendations and provide value maximization for their clients. They can also use this information to investigate anomalies in expected returns that are not explained by the standard economic indicators as a way to better appreciate the dynamics within the economy and improve portfolio returns. Policy makers within the Government can use the findings within this study to better align their fiscal and monetary policies. This study will provide incentives for greater fiscal discipline so as to provide a stable environment for sustainable development. The ultimate goal of a government is to improve the living conditions of people in their everyday lives. Increasing the gross domestic product is not just a numbers game. Higher incomes mean good food, warm houses, and hot water. They mean safe drinking water and inoculations against the perennial plagues of humanity which in turn help to break the cycle of poverty to produce a wealthy nation. This requires growth in real productive sector and a balance between the value to invest in Treasury bills and the amount of funds to leave available in order to extend credit to the economy.

LITERATURE REVIEW

LINK BETWEEN STOCK MARKET AND T-BILL RATE

Darrat and Dickens (1999) noted that interest rates lead stock returns. Various studies such as the June 2004 study by the CFA Institute show that stocks in the US averaged greater returns during periods of expansive monetary policy and smaller returns were realized when the policy on interest rates was restrictive and that markets performed poorly, resulting in lower than average returns and higher than average risk. Conversely, periods of expansive monetary policy - when interest rates are falling, generally coincide with strong stock performance including higher than average returns and less risk.

TREASURY BILL RATE AND CROWDING OUT EFFECT

In Kenya, the major purchasers of TBills tend to be financial institutions, Mukherjee (1999). These same institutions are responsible for providing credit to individual and corporate consumers. When financial institutions purchase of T-bills, the amount of money available for private investment and development is curtailed and is expensive. (Girmens and Guillard, 2002) and (Schenk, 2000). This result into the crowding out effect, i.e. an increase in interest rates due to rising government borrowing in the money market, (Girmens and Guillard,2002), (Ahmed and Miller, 1999).

THE ATTRACTIVENESS OF T-BILLS TO INVESTORS

Treasury bill rates are normally the lowest of rates within the economy. They are influenced mainly by the expectations about government budget deficits, government short-term cash-management needs, inflation, as well as overall conditions of demand and supply in the markets for credit, Wagacha (2001), Fleming (1997), Stanton (2000). In some countries e.g. United States, the interest paid on Treasury bills includes an inflation premium for any expected loss of purchasing power, Kopcke and Kimball (1999). At the same time, however, Treasury bill rates probably have only a small or no liquidity premium for holding bills instead of cash because holders have a ready market in which to sell the bills, should they need cash before the maturity date. Also missing from the interest rate paid on Treasury bills is a credit-risk premium to offset the chance that the issuer might default because of the superior credit standing of the government, Stanton (2000).

Thus given an opportunity, a risk averse investor will always opt for T-bills rather than risky securities whenever Treasury bills offer higher returns. In fact, during turbulent financial times, investors' increased desire for default-free assets tends to produce particularly low interest rates on Treasury bills compared with money market instruments issued by the private sector, Federal Reserve Bank of San Francisco (2005). This is because as the demand for T-bills increase, their interest rate goes down.

THE STOCK EXCHANGE AS A PREDICTOR OF THE ECONOMY

Central Bank of Kenya's (CBK) monthly economic review reports the performance of the Nairobi Stock Exchange (NSE) as one of the economic indicators. The report includes the movements of the NSE-20 price index as well as percentage (%) trade turnover in securities

listed at the Nairobi Stock Exchange (NSE) and the performance of the 91 day Treasury bill. This suggests that the CBK is aware of the importance of the NSE as a “predictor” of the economy and hence to some extent is aware of the association between changes in economy and movements in the NSE 20 share index. Lawrence Kudlow, Chief Economist for CNBC, the leading financial news television network in the world, says that “The stock market index signals to the government the ‘feel good’ factor prevailing in the economy” Kudlow (2001). As much as the finance ministry may want to ignore it, the performance of the stock market right after the introduction of the budget gives an immediate feedback to the Finance Minister about the acceptability of the budget. The NSE – 20 Index is considered effective and representative, Odhiambo (2000).

The “wealth effect” holds that stock prices lead economic activity by actually causing what happens to the economy. Dynan and Dean (2001) argue that since fluctuations in stock prices have a direct effect on aggregate spending, the economy can be predicted from the stock market. When the market is rising, investors are wealthier and spend more. As a result, the economy expands. On the other hand, if stock prices are declining, investors are less wealthy and spend less. This results in slower economic growth.

As mentioned previously in this document students of finance and professionals within the finance and economic sector in Kenya have been interested in the performance of assets on the NSE and the ability to predict the same using various factors. The studies are mainly the unpublished MBA thesis projects presented at the University of Nairobi and a few published articles by professionals in the Institute of Policy and Research (IPAR) Kenya. Similar studies by Njaramba (1990), Kerandi (1993), Gathoni (2002) relied on OLS regression. Akwimbi (2003) investigated the relationship of NSE stock returns to selected market and industrial variables. He focused on loans, interest on savings among others and concluded that there is no significant relationship between these factors and the returns of assets on the stock exchange. Rioba (2003) carried out a study to determine the predictability of ordinary stock returns for selected securities listed on the NSE using recursive least squares regression. He concluded that the predictability evidence for ordinary shares is weak and not conclusive.

The above studies yielded inconclusive evidence in predicting the returns of assets on the NSE. This clearly indicates that practical considerations on the ground do not necessarily

agree with the theory of the day and compels finance scholars and professionals to explain why there is a discrepancy between reality and theory.

The study is unique in that it utilizes an analysis model other than OLS regression to compare returns of riskless asset against risky asset. As mentioned previously, GARCH has been gaining huge success and popularity in academic and professional financial circles since its introduction by Engle in 1920 and its significant enhancement by Bollerslev in 1996. The deluge of GARCH material and its ability to capture the volatility inherent in financial data prompted its use in this study. OLS Regression limits the variance over time to a constant usually referred to as the “error” term. The term itself “error” is a misnomer as it suggests a parameter that is captured as a “by the way”, yet statistic theory has shown that residuals in financial data are rich in volatility content.

GARCH stands for Generalized Autoregressive Conditional Heteroskedasticity. Heteroskedasticity is the time-varying variance i.e., volatility. Conditional implies a dependence on the observations of the immediate past, and autoregressive describes a feedback mechanism, by which past observations are incorporated into the present. GARCH then is a mechanism by which past variances are included in the explanation of future variances. More specifically, GARCH is a time series modeling technique by which past variances and past variance forecasts are used to forecast future variances.

ARCH models were introduced by Engle (1982) and generalized as GARCH (Generalized ARCH) by Bollerslev (1986). These models are widely used in various branches of econometrics, especially in financial time series analysis, Bollerslev, Chou, and Kroner (1992) and Bollerslev, Engle, and Nelson (1994). Estimates of asset return volatility are used to assess the risk of many financial products. Accurate measures and reliable forecasts of volatility are crucial for derivative pricing techniques as well as trading and hedging strategies that arise in portfolio allocation problems.

Financial return volatility data is influenced by time dependent information flows which result in pronounced temporal volatility clustering. These time series can be parameterized using Generalized Autoregressive Conditional Heteroskedastic (GARCH) models. It has been found that GARCH models can provide good in-sample parameter estimates and, when the appropriate volatility measure is used, reliable out-of-sample volatility forecasts. Empirical

studies on financial time series have shown that they are characterized by increased conditional variance following negative shocks (bad news). The distribution of the shocks has also been found to exhibit considerable leptokurtosis. Since the standard Gaussian GARCH model cannot capture these effects various GARCH model extensions have been developed.

On a purely statistical level, non-constant variance (heteroskedasticity) constitutes a threat to inference as it biases the standard errors of coefficients. The standard approach to heteroskedasticity is to employ a number of “corrections” to overcome the statistical problems involved (e.g., White 1980). However, the presence of heteroskedasticity in a model can also indicate an underlying process that is theoretically interesting. In time series data, the unconditional, or long run, variance from a model may be constant even though there are periods where the variance increases substantially. These eruptions of high variance in some periods can be indicative of contextual volatility often hypothesized to occur in financial markets or public opinion. Mean models often fail to capture this dynamic because increases or decreases in conditional variance do not necessarily imply a change in the expected mean of the data.

The ARCH Specification

To develop garch ARCH model, one consider two distinct specifications—one for the conditional mean and one for the conditional variance. In the standard GARCH (1, 1) specification:

$$y_t = x_t\gamma + \varepsilon_t \quad \dots\dots\dots \text{Equation 1}$$

$$\sigma_t^2 = \omega + \alpha\varepsilon_{t-1}^2 + \beta\sigma_{t-1}^2 \quad \dots\dots\dots \text{Equation 2}$$

Where

- y_t = mean equation
- σ_t^2 = conditional variance equation
- ω = the mean

ε_{t-1}^2 = News about volatility from the previous period, measured as the lag of the squared residual from the mean equation i.e. the ARCH term.

σ_{t-1}^2 = Last period's forecast variance i.e. the GARCH term

The mean equation given in (1) is written as a function of exogenous variables with an error term. Since σ_t^2 is the one-period ahead forecast variance based on past information, it is called the conditional variance. The conditional variance equation specified in (2) is a function of three terms namely the mean, the ARCH term and the GARCH term. The (1, 1) in GARCH (1, 1) refers to the presence of a first-order GARCH term (the first term in parentheses) and a first-order ARCH term (the second term in parentheses). An ordinary ARCH model is a special case of a GARCH specification in which there are no lagged forecast variances in the conditional variance equation.

This specification is often interpreted in a financial context, where an agent or trader predicts this period's variance by forming a weighted average of a long term average (the constant), the forecasted variance from last period (the GARCH term), and information about volatility observed in the previous period (the ARCH term). If the asset return was unexpectedly large in either the upward or the downward direction, then the trader will increase the estimate of the variance for the next period. This model is also consistent with the volatility clustering often seen in financial returns data, where large changes in returns are likely to be followed by further large changes. There are two alternative representations of the variance equation that may aid in the interpretation of the model. If we recursively substitute for the lagged variance on the right-hand side of (2), we can express the conditional variance as a weighted average of all of the lagged squared residuals:

$$\sigma_t^2 = \frac{w}{1-\beta} + \alpha \sum_{j=1}^{\infty} \beta^{j-1} \varepsilon_{t-j}^2 \dots\dots\dots \text{Equation 3}$$

We see that the GARCH (1, 1) variance specification is analogous to the sample variance, but that it down-weights more distant lagged squared errors.

The second representation the error in the squared returns is given by $v_t = \varepsilon_t^2 - \sigma_t^2$. Substituting for the variances in the variance equation and rearranging terms we can write our model in terms of the errors:

$$\varepsilon_t^2 = \omega + (\alpha + \beta\varepsilon_{t-1}^2 + v_t - \beta v_{t-1}) \quad \dots\dots\dots \text{Equation 4}$$

Thus, the squared errors follow a heteroskedastic ARMA (1, 1) process. The autoregressive root which governs the persistence of volatility shocks is the sum of α and β . In many applied settings, this root is very close to unity so that shocks die out rather slowly. To gain theoretical purchase on conditional volatility, it can be useful to model the variance directly by introducing theoretically relevant variables that may account for the heteroskedastic nature of the disturbances. This has the advantage of increasing the efficiency of estimates in the mean model while providing substantive information about the variance process.

The Case for Using GARCH Analysis

One problem with using regular linear regression to evaluate the data of TBills Interest Rate and returns of various stocks on the NSE is that whilst it gives us an idea of the implied volatility taking into account the current view of the market, it does not give us any insight into possible future changes in volatility. Given that the value of a stock is primarily driven by the risk (volatility) and expected return, making predictions is a valuable tool from a practitioner's perspective.

GARCH is well suited to modeling the volatility and adjusting the original modeling equation using the information obtained from the analysis of the variances. The most striking feature is that periods of high volatility tend to cluster together. Therefore, one would expect the volatilities to be correlated to some extent. The other noticeable feature is that the volatility tends to revert to some long-running average - a property commonly known as mean-reversion. The mean-reversion nature of the volatilities helps ensures that the process remains statistically stationary. It is these characteristics of the residuals that lend themselves to the GARCH process. The various graphs for all the market segments reveal a similar trend.

Lubrano (1998) notices that, when describing the transition between two regimes denoted by a threshold, simple GARCH is ineffective. Indeed a cursory examination of time series data shows that there are sharp transitions from positive to negative and from low values of positive to very high values of positive. Lubrano (1998) introduced a new class of GARCH models that allows for a smooth transition and named it STGARCH - Smooth Transition GARCH. As financial data have very often a high frequency of observation, a smooth transition seems a priori better than an abrupt transition. Engle and Ng (1993) found that the most severe misspecification direction was that the tested models did not take adequately account for the sign asymmetry. The smooth transition model addresses the problem of sign asymmetry. It is more than a simple generalization of the TGARCH as it allows for various transition functions that assure a great flexibility to the skedastic function, taking into account sign but also size effects. Finally the specification retained accepts the simple GARCH as a restriction.

Modeling Financial Returns Volatility

In this section we take a week as the unit time interval and identify return as the continuously compounded weekly asset return r_t expression for r_t is then:

$$r_t = \text{Log}(p_t) - \text{Log}(p_{t-1}) \dots\dots\dots \text{Equation 5}$$

Where Log denotes the natural logarithm and is the asset's (close of trade) value on week t . The weekly return volatility on week t is then

$$\sigma_t^2 = r_t^2 \dots\dots\dots \text{Equation 6}$$

If a standard GARCH (1, 1) model is assumed then a one step-ahead out-of-sample weekly volatility forecast can be constructed as:

$$\sigma_{t+1}^2 = \alpha_0 + \alpha_1 \varepsilon_t^2 + \beta \sigma_t^2 \dots\dots\dots \text{Equation 7}$$

Where

$$\varepsilon_t = y_t - b_0 - x_t^T b_1 \dots\dots\dots \text{Equation 8}$$

and

$$\sigma_{t+1}^2 = r_{t+1}^2 \dots\dots\dots \text{Equation 9}$$

However, empirical research has shown that GARCH is not good a estimator of r_{t+1}^2 and that much improved volatility forecasts can be obtained if high frequency (daily or intraday) returns data are taken into account.

To be specific, if the asset price is sampled m times per day then the following returns are generated:

$$r_{(m)t} = \text{Log}(p_t) - \text{Log}(p_{t-1/m}) \dots\dots\dots \text{Equation 10}$$

Where

$t = 1/m, 2/m, \dots$ Etc. and the cumulative squared returns (CSR) for day $t + 1$ are:

$$CSR_{(m)t+1} = \sum_t^m r_{(m)t+1}^2 \dots\dots\dots \text{Equation 11}$$

If $CSR_{(m)t+1}$ is used instead of r_{t+1}^2 then standard GARCH models can provide satisfactory volatility forecasts. In fact the quality of these forecasts has been found to increase monotonically as the sampling frequency (m) increases.

METHODOLOGY

The study uses all the securities listed in the Nairobi Stock Exchange (NSE) as the and their various market segments as the dependent variable and the 30-day treasury bill rate as the independent variable. The securities are divided into various categories in order to get a clearer picture of the impact of Treasury Bill Rate impact on the market as a whole, the companies that constitute the NSE – 20 Share Index, and the companies that make up the various market segments, namely Financial and Investment, Agriculture, Commercial and Services, and Industrial.

The sample consists of securities comprising the calculation of the NSE 20 share index. The government security is the 90-day Treasury bill. The sample is further broken down into the various market segments in order to get a clearer understanding of the impact of the TBills interest rate. The study is limited to the period 1996 to 2001 since data is readily available during this period.

THE VARIABLES AND THEIR MEASUREMENTS

We have two assets whose return and risk we need to compute. These are stocks and the 90-day Treasury bill. Return on Stocks and Market Index is calculated as follows:

$$R_i = \frac{P_i - P_0 + D_1}{P_0} \dots\dots\dots \text{Equation 12}$$

Where:

R_i = Return on asset (stock) I ; P_i = Price of share (stock) at period t ; P_0 = Price of share (stock) at period $t-1$; and D_1 = Dividend paid during the period on stock .

The above formulation will be used in calculating return on stocks that constitute NSE 20 share index on a weekly basis. The weekly frequency is dictated by the fact that T-bill interest rates are released in most cases weekly and the fact that a larger time scale, with more intervals of data improves the precision of estimates. The return will then be converted into weekly annual returns to be comparable to Treasury bill rates reported by weekly by Central Bank of Kenya.

Market Return (R_m) is based on NSE 20 share market index is:

$$R_m = \frac{(R_{1t} + R_{2t} + R_{3t} \dots R_{nt})}{n} \dots\dots\dots \text{Equation 13}$$

Where:

R_m = the market return; R_{1t} = Return on stock of the first company in week t ; and
 n = The number of company in the index

The calculation of returns on treasury (r_{tb}) and is calculated by solving for r_{tb} in the following function:

$$PP_{tb} = \frac{MV}{(1 + r_{tb})^n} \dots\dots\dots \text{Equation 14}$$

Where:

PP_{tb} = Purchase price of the treasury bills; MV = Maturity value or face value of treasury bills; r_{tb} = The return on treasury bills; and n = The period to maturity

Stock returns variability is captured by the equation below:

$$\hat{\sigma}^2 = \frac{1}{T-1} \sum_{t=1}^T [R_t - \bar{R}]^2 \dots\dots\dots \text{Equation 15}$$

The numbers in both sets of data are converted in their logarithms. This non-linear logarithmic conversion of data is very useful when comparing the interest rate of T-bills with the changes in stock prices. By converting the data into logarithms the variability becomes roughly the same within each group (homoscedasticity) Maestas and Gleditsch (1998). Often groups that tend to have larger values also tend to have greater within-group variability. A logarithmic transformation will often make the within-group variability more similar across groups. This is especially useful for the stock prices. It is also easier to describe the relationship between the variables when it's approximately linear. Logarithmic transformations are helpful when constructing statistical models to describe the relationship between two measurements which in their original form seem to have no linear correlation. Finally, logarithms also play an important role in analyzing probabilities.

Earlier studies modeled the relationship between stock returns and TBill returns using regression analysis. Such studies overlooked the possibility that when time series data are used in regression analysis, often the error term is not independent through time. Instead, the errors are serially correlated or autocorrelated. If the error term is autocorrelated, the efficiency of ordinary least-squares (OLS) parameter estimates is adversely affected and standard error estimates are biased.

In this study, it is assumed that the error term is varying or increasing with each observation due to the time series nature of the data. Each set of data represents a different week which introduces its own errors into the data.

ROAD MAP OF DATA ANALYSIS

The data is put through basic data analysis to get a feel for the behaviour of the data in its raw format and also in its transformed format.

1. A basic correlation analysis will be carried out on the TBills Interest Rate on an annual basis and that of the stock returns for the various market segments. The purpose of this analysis will be to determine if TBills Rate are independent when compared to the rate of return of stocks. Only then can we make a decision as to whether we are dealing with a dependent and independent variables or dealing with a case of factor analysis.
2. The second step will be to analyze the distribution of TBills Interest Rates and see whether their distribution is linear or non-linear. The results from this step will help us narrow down the type of data transformation that will be required at advanced stages of the analysis.
3. The distribution of the returns of the various market segments will be undertaken to determine if the distribution is normal. The distribution of the various market segments will indicate whether the data needs to undergo a data transformation in order to come up with an appropriate relationship model between rate of return and TBills Interest Rate.
4. A test to determine whether the data is uniformly distributed will be the final descriptive test for the data. Presence of uniform distribution is an important assumption for carrying out various statistical tests. If the data does not have a uniform distribution it is important that we establish this fact and seek alternative analysis methods or transform it to obtain the desired characteristics.
5. The next step in accordance to the literature review is to establish the presence of autoregression within the residuals of the various market segment returns. This will be done using the Durbin Watson test and the ARCH LM Test. The Durbin-Watson test statistic is designed for detecting errors that follow a first-order autoregressive process. This statistic also fills an important role as a general test of model misspecification.
6. If the tests are positive for GARCH we will run ordinary linear regression and compare the results to GARCH (1, 1) and other higher order GARCH models and test

to see if the GARCH estimation has a better “goodness of fit” compared to OLS regression.

7. The graphs of the various returns over time will then be analyzed to examine the behaviour of the market segments when TBills rise and fall. The points for examination will be generated from the TBill Graph’s high and low points.

DATA ANALYSIS AND FINDINGS

The process of data analysis is governed by the Road Map that described above. It starts from basic analysis of the data to determine its properties, these form the basis for the various analysis that the data will be subjected to during the analysis stage. The analysis then graduates to more specific analysis of graphs, which gives us a better feel for the behaviour of the data not only in general but across certain time periods. Finally the data is subjected to OLS Linear Regression and GARCH regression and the results are obtained. The comparison of these two analysis techniques forms the final part of the analysis as we examine the best fit model for each market sector.

Table 1 LEGEND OF ABBREVIATIONS USED IN THE DATA ANALYSIS	
AllRetnA	Returns for the entire Nairobi Stock Exchange taken on an annual basis
AgrRetA	Returns for the Agricultural Market Segment taken on an annual basis
ComRetA	Returns for the Commercial and Services Segment taken on an annual basis
FinRetA	Returns for the Financial and Investment Segment taken on an annual basis
IndRetA	Returns for the Industrial and Allied Segment taken on an annual basis
TBills R	Returns for the Treasury Bills taken on an annual basis
NSEIRetA	Returns for the for the NSE – 20 Share Price Index taken on an annual

	basis
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Table 4.1

CORRELATION ANALYSIS

The null hypothesis in this case states that there is no correlation

$$H_0: \rho = 0$$

And the alternative hypothesis states that there is a correlation

$$H_1: \rho \neq 0$$

p - value < 0.05 there is evidence to support correlation; p - value > 0.05 there is evidence to support **no** correlation. If a strong correlation exists, then the analysis shifts to factor analysis as opposed analysis of independent variables. This ensures that the analysis technique employed is suitable for the type of data we have.

CORRELATION ANALYSIS OF THE VARIOUS MARKET SEGMENTS							
		A	B	C	D	E	F
		NSEIRetA	AllRetnA	AgrRetA	ComRetA	FinRetA	IndRetA
1.	AllRetnA	0.720	The p value << 0.05 and hence supports the fact that there is a strong correlation				
		0.000					
2.	AgrRetA	0.434	0.379	The p value << 0.05 and indicates there is evidence to support correlation, albeit a weak form of correlation			
		0.000	0.000				
3.	ComRetA	0.256	0.506	0.052	Weak form of correlation for all except C3 which indicates that there is evidence to reject existence of correlation.		
		0.000	0.000	0.373			
4.	FinRetA	0.617	0.709	0.158	0.212	Weak correlation for all except B4 which indicates strong correlation	
		0.000	0.000	0.006	0.000		
5.	IndRetA	0.471	0.772	0.148	0.191	0.365	Weak correlation except for B5 which has strong correlation
		0.000	0.000	0.000	0.000	0.000	
6.	TBills R	0.090	0.050	0.144	0.042	-0.006	-0.040
		0.121	0.389	0.013	0.472	0.924	0.491

The p value $\gg 0.05$ and indicates there is no correlation with the exception of C6 which indicates there is evidence to accept the existence of a very weak form of correlation

Table 2

The data above shows that a strong correlation exists between AllRetA and NSEIRetA. This is a good indication because it indicates that the NSEI – 20 Share Price Index is a good estimator of overall market performance. Worthy of note is the strong positive correlation between the Financial and Investment Sector and the Industrial and Allied Sector and the returns of the market in its entirety. This strong positive correlation is made more interesting when one notes the lack of similar correlation between these sectors and the NSEIRetA.

In general, the data shows that there is very little correlation between the Treasury Bill Interest and the various market segments. As such, the Treasury Bills Interest Rate can be used as an independent variable in the analysis of the various market segments as well as the entire market. This eliminates the need for factor analysis and allows us to proceed to the next step of our examination.

IS THE DATA LINEAR?

This stage of the data analysis examines the nature of the data for its linearity purposes. This is because non-linear data will have to be subjected to logarithmic transformation in order to prepare it for analysis via techniques that require the data to be linear. The result of the various graphs indicates that all the data is non linear in nature, and may need logarithmic transformation for purposes of further analysis especially when using OLS regression. GARCH analysis does not require the data to be linear in nature in order to give reliable results.

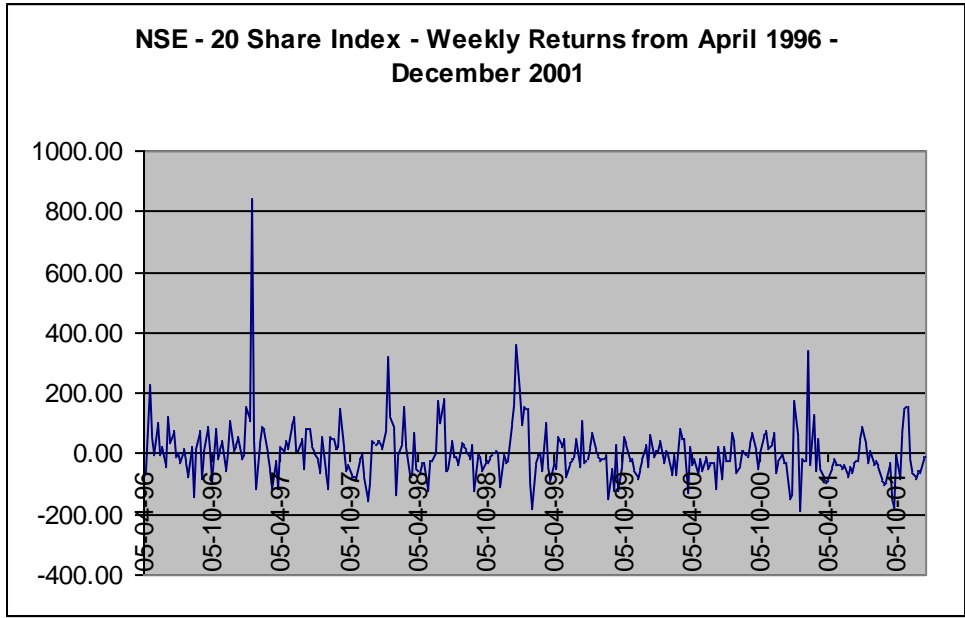


Table 4.3

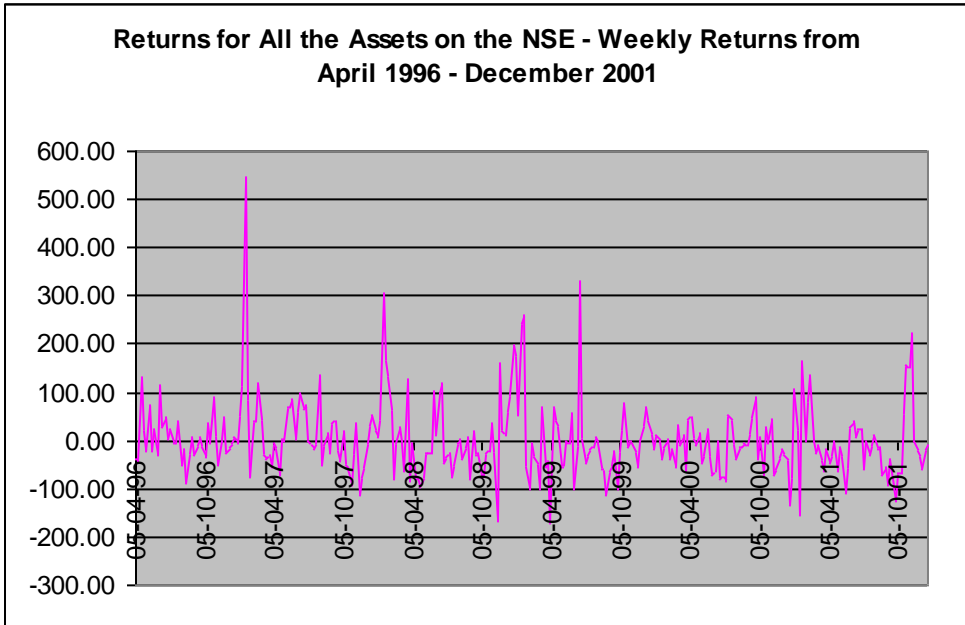


Table 4

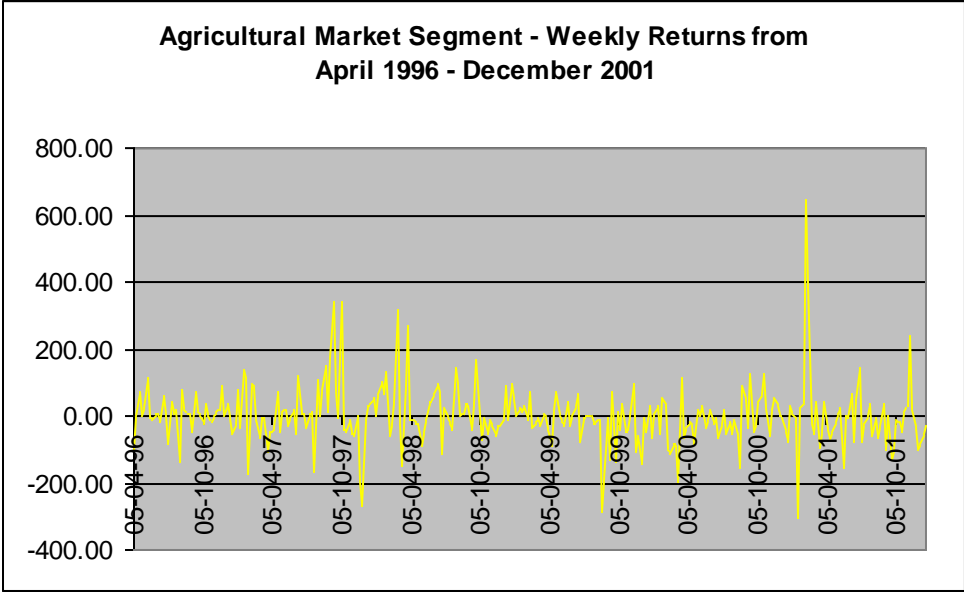


Table 5

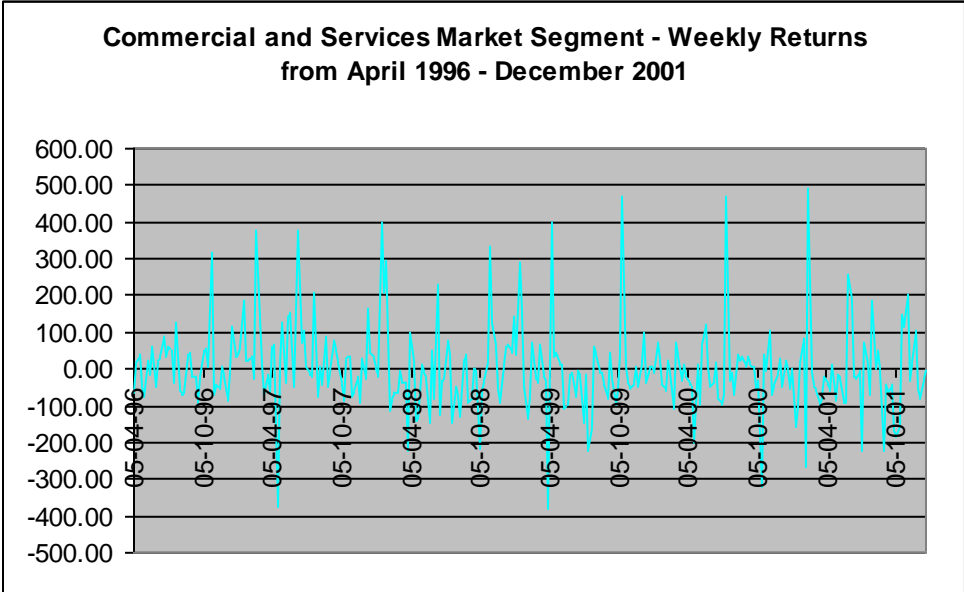


Table 6

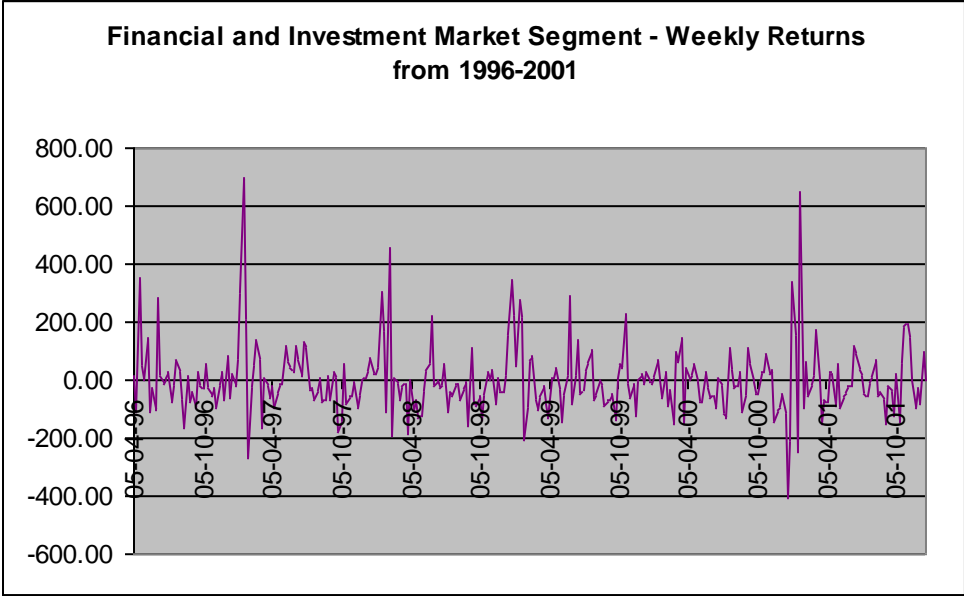


Table 7

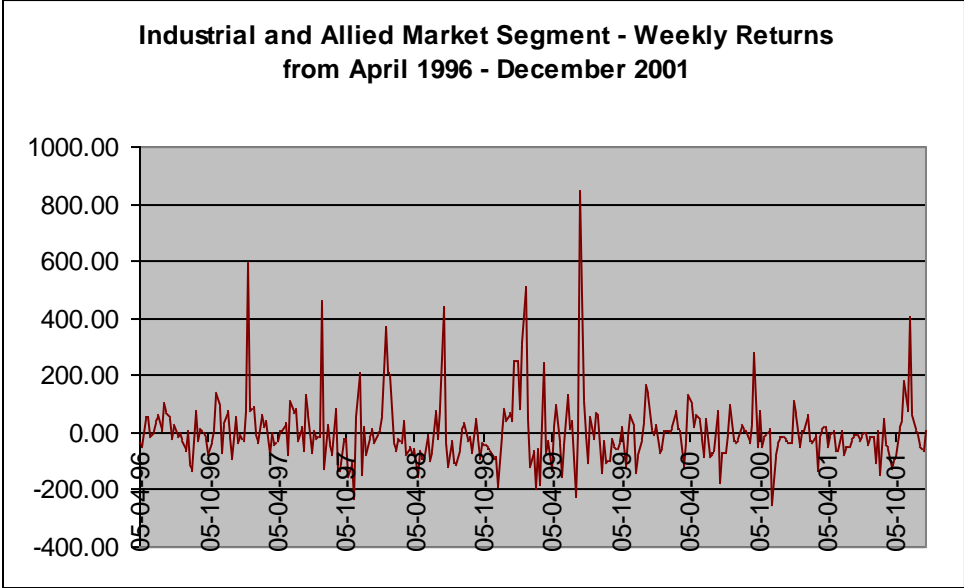


Table 8

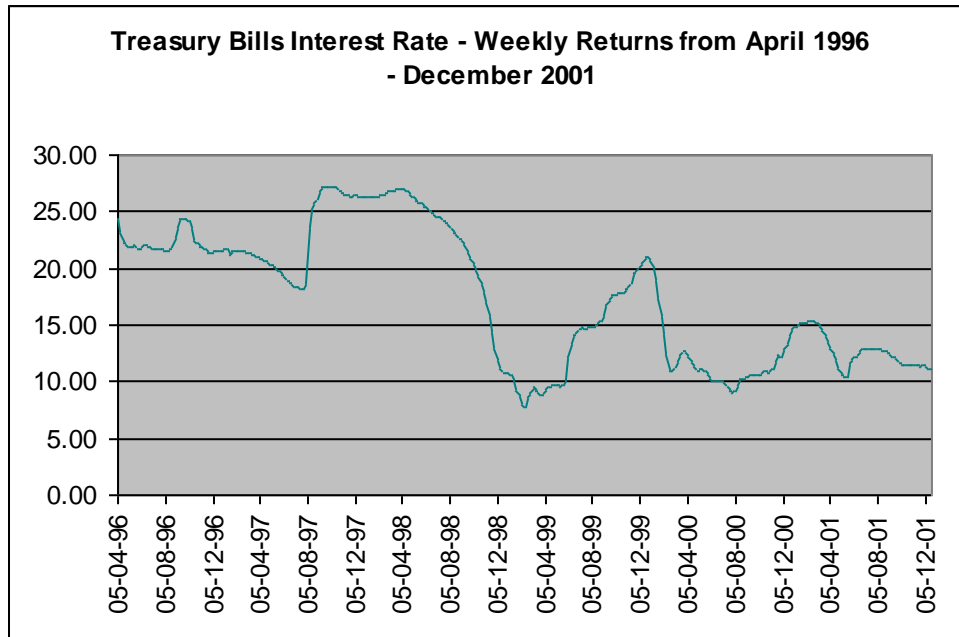


Table 9

ANALYSIS OF DISTRIBUTION TRENDS

Kurtosis describes the shape of a random variable’s probability density function (PDF). A normal random variable has a kurtosis of 3 irrespective of its mean or standard deviation. A random variable’s kurtosis greater than 3, is leptokurtic but if kurtosis is less than 3, it is platykurtic. The **Jarque-Bera** is a statistic that shows if a sample could have been drawn from a normal distribution. It relies on the statistics of kurtosis and skewness. The statistic is computed as:

$$JB = \frac{N - k}{6} \left[S^2 + \frac{1}{4} (K - 3)^2 \right] \dots\dots\dots \text{Equation 1}$$

Where S is the skewness, K is the kurtosis, and k represents the number of estimated coefficients used to create the series. Under the null hypothesis of a normal distribution, the Jarque-Bera statistic is distributed as with 2 degrees of freedom. The reported probability is the probability that a Jarque-Bera statistic exceeds (in absolute value) the observed value under the null—a small probability value leads to the rejection of the null hypothesis of a normal distribution. A Jarque-Bera statistic of 0 indicates that the distribution has a skewness of 0 and a kurtosis of 3, and is therefore judged to come from a normal distribution. Skewness values other than 0 and kurtosis values farther away from 3 lead to increasingly large Jarque-Bera values.

- H₀: The distribution is not normal
- H₁: The distribution is normal

NORMAL DISTRIBUTION SUMMARY - TABLE A								
		A	B	C	D	E	F	G
	Series Name	Mean	Std. Dev	Skewness	Kurtosis	Jarque-Bera	Prob.	Status
1.	TBills Rate	17.44	005.93	0.13	01.60	25.26	0.00	REJECT
2.	AgrRetA	-0.017	090.69	1.67	13.86	1610.25	0.00	REJECT
3.	AllRetA	0.817	076.70	2.21	13.03	1478.53	0.00	REJECT
4.	ComRetA	1.815	114.97	1.06	7.288	286.15	0.00	REJECT
5.	FinRetA	-1.289	117.13	1.78	10.98	952.84	0.00	REJECT
6.	IndRetA	1.519	116.46	2.66	16.17	2517.1	0.00	REJECT
7.	NSEIRetA	1.584	092.09	3.07	26.13	7136.95	0.00	REJECT

Table 10

NORMAL DISTRIBUTION SUMMARY - TABLE B								
		A	B	C	D	E	F	G
	Series Name	Mean	Std. Dev	Skewness	Kurtosis	Jarque-Bera	Prob.	Status
	Log(TBills Rate)	2.79	0.35	0.17	1.62	25.20	0.000003	REJECT
	Log(AgrRetA)	3.42	1.40	-0.70	3.40	14.10	0.000885	REJECT
	Log(AllRetA)	3.48	1.43	-1.12	4.76	40.00	0.000000	REJECT
	Log(ComRetA)	3.78	1.24	-0.28	2.89	01.89	0.387173	REJECT
	Log(FinRetA)	3.75	1.37	-0.67	3.74	12.94	0.001550	REJECT
	Log(IndRetA)	3.65	1.41	-0.51	3.22	05.92	0.051643	REJECT
	Log(NSEIRetA)	3.65	1.20	-0.79	4.86	33.00	0.000000	REJECT

Table 11

The analysis for normality was carried out on the raw data itself (Table A) as well as on the data that had been transformed using logarithms (Table B). Although Table A above gives very large values for Jarque-Bera the inherent probabilities are very low to the order of 0.00000. This indicates that the distributions of the various market segment returns are normally distributed. Table B gives a better picture with smaller JB statistics ranging from a maximum of 40 for All Returns to 1.89 for Commercial and Services Sector. Further perusal of histograms generated give confirmation to the fact that the data is normally distributed. The above analysis indicates the presence of normally distributed data and hence reassures us that data interpretation using t-statistics, p-values and other methods is

acceptable because the data exhibits Gaussian distribution.

The literature review noted that GARCH analysis is well suited to Financial Data Time series due to the unique nature of such data. These properties include “fat tails” - excess kurtosis and volatility clustering, two important characteristics of financial time series. The above test provides information on Kurtosis as well as the presence of the normal distribution of the data. The above analysis confirms that all the market segments depict excess kurtosis whether the analysis is done on the original raw data, or on the data that has undergone logarithmic transformation. It also shows that transformation of data into its logarithmic form gives better results than working on the raw data. The only exception to this rule is TBills data which is not affected by logarithmic transformation. Its Kurtosis and JB Statistic remain consistent across the transformation. This prompts the re-examination of the linear nature of the TBills as obtained in the data analysis above.

ONE WAY ANOVA ANALYSIS - SUMMARY DATA

ONE WAY ANOVA ANALYSIS SUMMARY DATA				
Item	Description	F	P	Conclusion
1.	NSEIRetA, AllRetA	0.01	0.912	Accept
2.	AllRetA, AgrRetA, ComRetA, FinRetA, IndRetA	0.04	0.996	Accept
3.	AgrRetA, TBills Rate	11.04	0.001	Reject
4.	ComRetA, TBills Rate	5.51	0.019	Reject
5.	FinRetA, TBills Rate	7.63	0.006	Reject
6.	IndRetA, TBills Rate	5.58	0.019	Reject
7.	NSEIRetA, AllRetA, TBills Rate	5.49	0.004	Reject
8.	NSEIRetA, TBills Rate	8.83	0.003	Reject
9.	AllRetA, TBills Rate	13.97	0.000	Reject

Table 12

The null hypothesis for ANOVA states that the means are equal.

$$H_0: \mu_1 = \mu_2 = \dots \mu_k$$

The alternative hypothesis for ANOVA states that the means are not equal.

$$H_1: \mu_1 \neq \mu_2$$

The data above was calculated using a confidence level of 95%. For 1 and 2 above the null hypothesis is accepted indicating that the means of NSEIRetA and AllRetA on an annual basis have equal means with similar dispersion patterns. This is not surprising considering the fact that the NSEI – 20 Share Price is meant to be a proxy for the returns of the entire stock exchange.

The same applies for the means and dispersion patterns of all the different market segments (Financial and Investments, Commercial and Services, Agriculture, Industrial and Allied) matched against the returns of the entire stock market (AllRetA) on an annual basis. Looking at 4 – 10 above, we note that the null hypothesis is rejected, indicating that the Treasury Bills Interest Rate has an impact on the rate of return of stocks in the various market segments within the Nairobi Stock Exchange as measured on an annual basis.

TESTING FOR PRESENCE OF ARCH IN THE VARIABLES

The Durbin Watson statistic is used to test for the presence of first-order autocorrelation in the residuals of a regression equation. The test compares the residual for the time period t with the residual from the time period $t-1$ and develops a statistic that measures the significance of the correlation between successive comparisons. The statistic is used to test for the presence of both positive and negative correlation in the residuals. The statistic has a range of from 0 to 4, with a midpoint of 2. The Null Hypothesis is that there is no significant correlation. The second part of this analysis will test for conditional heteroskedasticity using White's test. The results will be reflected using the f-statistic and the p-statistic. The Null Hypothesis for Whites test is that there is no Conditional Heteroskedasticity and the alternative hypothesis is that there is presence of conditional heteroskedasticity

Regions of Acceptance and Rejection of the Null Hypothesis				
0 - D_L	D_L to D_U	D_U to (4- D_U)	(4- D_U) to (4- D_L)	(4- D_L) to 4
0 - 1.65	1.65 - 1.69	1.69 – 2.31	2.31 - 2.35	2.35 - 4
Reject Null Ho Positive Autocorrelation	Neither Accept or Reject	Accept the Null Hypothesis	Neither Accept or Reject	Reject Null Ho Negative Autocorrelation

Table 13

ARCH RESULTS PER MARKET SEGMENT								
		A	B	C	D	E	F	G
Item	Description	Durbin Watson	D_L	D_U	Type Of Autocorrelation	F Statistic	Prob.	Null Hypothesis
1.	AgrRetA	1.58	1.65	1.69	Positive Autocorrelation	0.54	0.58	THERE IS CH
2.	AllRetnA	1.36	1.65	1.69	Positive Autocorrelation	0.01	0.98	THERE IS CH
3.	IndRetnA	1.55	1.65	1.69	Positive Autocorrelation	0.23	0.79	THERE IS CH
4.	NSEIRetnA	1.49	1.65	1.69	Positive Autocorrelation	0.29	0.74	THERE IS CH
5.	ComRetnA	1.87	1.65	1.69	No Autocorrelation	0.28	0.75	THERE IS CH
6.	FinRetnA	1.73	1.65	1.69	No Autocorrelation	0.33	0.71	THERE IS CH

Table 14

The first four columns A, B, C and D give results pertaining to the Durbin Watson Criteria and the last three columns E, F and G give results from White's Test.

The upper and lower limits of the d statistic are given for $k=1$, and for a confidence interval of 0.05.

The null hypothesis states that there is no autocorrelation, otherwise known as ARCH (1)

Ho: There is NO ARCH (1)

H₁: There is ARCH (1)

Interpretation of the results using the upper and lower limits of the Durbin Watson tables for one independent variable and 299 observations, for a confidence level of 0.05 yields a lower limit of 1.65 and an upper limit of 1.69. The residuals of the Commercial and Services Market Segment and the Financial and Investment market Segment, indicate that there is no autocorrelation. The results of 1, 2, 3 and 4 indicate that there is positive autocorrelation in the residuals of the returns of stocks in the Agriculture Market Segment and the Industrial and Allied Market Segment. The residuals of the returns of the all the stocks within the market analyzed on an annual basis show that there is autocorrelation present. Autocorrelation is also positive for the residuals of the returns of the stocks of the companies that make up the NSE 20 Index. The results from column E, F and G indicate that all the market segments indicate presence of conditional heteroskedasticity including commercial and services as well as financial and investment segments.

The above result indicates presence of ARCH in the dependent and independent variables and has established the necessary criteria to undertake GARCH analysis.

ORDINARY LEAST SQUARES ANALYSIS

OLS RESULTS FOR THE DIFFERENT MARKET SEGMENTS						
		A	B		C	D
		F	P	Goodness of Fit	R-Sq	R-Sq (adj)
1.	AllRetnA vs. TBills Rate	0.74	0.389	Reject	0.2%	0.0%
2.	AgrRetA vs. TBills Rate	6.29	0.013	Reject	2.1%	1.7%
3.	ComRetA vs. TBills Rate	0.52	0.472	Reject	0.2%	0.0%
4.	NSEIRetA vs. TBills Rate	0.74	0.455	Reject	0.1%	0.1%
5.	FinRetA vs. TBills Rate	0.01	0.924	Accept	0.0%	0.0%
6.	IndRetA vs. TBills Rate	0.48	0.491	Accept	0.2%	0.0%

Table 15

Ho: Acceptable Goodness of Fit

H1: Unacceptable Goodness of Fit

The above data shows that the summary outputs of subjecting the data to OLS regression. For the sectors indicated in 1, 2, 3, and 4 against TBills Rate there is a poor fit and this yields an adjusted coefficient of determination of 0%, 1.7%, 0% and 0.1% respectively. This means Treasury Bill Rate have a very small impact on the returns of the entire stock exchange as well as the Agriculture, and Commercial and Services sectors. The data shows that for 4, and 5 the goodness of fit is acceptable within a confidence interval of 95%, although the coefficient of determination is very low and yields a 0% explanation between the Treasury Bill Interest Rate and the Financial and Investment Sector and the Industrial and Allied Sector. The number of unusual observations in the various sectors is very high with standardized residuals ranging from 7.10 to -3.48 across the board. This further confirms that fact that T-Bill Rate has an insignificant impact on the return of stocks in the various market segments within the NSE. This is not in keeping with the CAPM model and the APT model which indicate that the T-bill Rate is a key factor in determining the return of an asset.

GARCH ANALYSIS

The R-squared R^2 statistic measures the success of the regression in predicting the values of the dependent variable within the sample. It is the fraction of the variance of the dependent variable explained by the independent variables. The statistic will equal one if the regression fits perfectly, and

zero if it fits no better than the simple mean of the dependent variable. It can be negative if the regression does not have an intercept or constant, or if the estimation method is two-stage least squares. One problem with using R^2 as a measure of goodness of fit is that the R^2 will never decrease as you add more regressors. In the extreme case, you can always obtain an R^2 of one if you include as many independent regressors as there are sample observations. The adjusted R^2 , commonly denoted as $\overline{R^2}$, penalizes R^2 for the addition of regressors which do not contribute to the explanatory power of the model. The adjusted R^2 is computed as $\overline{R^2} = 1 - (1 - R^2) \frac{t-1}{t-k}$. The Theil inequality coefficient (TIC) always lies between zero and one, where zero indicates a perfect fit between the forecasted model and the actual terms.

Weak $\overline{R^2}$	0 – 2	Weak p statistic	>> 0.1
Moderate $\overline{R^2}$	2 – 5	Moderate p statistic	<< 0.1
Strong $\overline{R^2}$	5 and above	Strong p statistic	<< 0.05

AgrRetA	Linear Regression	GARCH (1,1)	GARCH (10,1)
Adj R^2	1.7%	-3.65%	-8.75%
f	6.290	(z)-1.6090	(z)-4.0190
p	0.013	0.1076	0.0001
Theil I C	0.86	0.88	0.83
Goodness of fit	Weak $\overline{R^2}$ Strong p-statistic	Moderate $\overline{R^2}$ Moderate p-statistic	Strong $\overline{R^2}$ Strong p-statistic
Status	Average Fit	Good Fit	Excellent Fit

Table 16

From the above results we observe that the TIC is strong at 0.83 to 0.88 for GARCH (1, 1) model. Further analysis into the $\overline{R^2}$ statistic, shows that it keeps on improving as we move from linear regression to GARCH (1,1) and gives us the best fit for GARCH (10,1). Thus we can conclude that the GARCH model gives a better fit than the linear regression model across the board when all the statistics are examined.

FinRetA	Linear Regression	GARCH (1,1)	GARCH (5,1)
Adj R²	0.0%	4.17%	8.1%
f	0.48	(z) 5.4958	3.930
p	0.92	0.000	0.000
TIC	0.987	0.764	0.750
Goodness of fit	Very Weak $\overline{R^2}$ Poor p-statistic	Moderate $\overline{R^2}$ Strong p statistic	Strong $\overline{R^2}$ Strong p statistic
Status	Weak Fit	Good Fit	Excellent fit

Table 17

The above analysis reveals that the $\overline{R^2}$ statistic keeps improving as we move from linear regression to GARCH (5, 1) which yields an $\overline{R^2}$ of 8.1% compared to 0.0% of Linear Regression. The Theil Inequality Coefficient shows a stronger fit for the linear regression as compared to the GARCH regressions. This is not surprising considering the fact that Annual Returns for the Financial and Services Sector showed no traces of autocorrelation in their residuals. However, GARCH still gives a better fit when you consider that it gives superior readings for all three parameters.

ComRetA	Linear Regression	GARCH (1,1)	GARCH (10,1)
Adj R²	-0.16%	-1.54%	-4.96%
f	0.5177	0.0922	(z) 0.1030
p	0.4723	0.9934	0.9179
TIC	0.95	0.907	0.95
Goodness of fit	Weak $\overline{R^2}$ Weak p-statistic	Weak $\overline{R^2}$ Weak p-statistic	Moderate $\overline{R^2}$ Weak p statistic
Status	Weak Fit	Weak Fit	Average Fit

Table 18

The analysis of the annual returns of the commercial and services sector indicate a strong TIC that ranges from 0.907 to 0.95 for both linear regression as well as GARCH (10, 1). The $\overline{R^2}$ statistic keeps improving from -0.16 for the linear regression to -4.96 for GARCH (10, 1). Since the GARCH (10, 1) yields a stronger $\overline{R^2}$ than the linear regression equation, and results in similar TICs, the GARCH estimation is deemed superior to the Linear Regression one. Recall, that this market segment tested negative for autocorrelation and this may explain why GARCH and Linear Regression have such

strong TIC values.

IndRetA	Linear Regression	GARCH (1,1)	GARCH (10,1)
Adj R²	0.0%	12.80%	-3.67%
f	0.480	9.7800	0.1886
p	0.491	0.0000	0.9992
TIC	0.96	0.94	0.94
Goodness of fit	Weak $\overline{R^2}$ Weak p-statistic	Strong $\overline{R^2}$ Strong p-statistic	Moderate $\overline{R^2}$ Poor p-statistic
Status	Poor fit	Excellent Fit	Average fit

Table 19

The Theil inequality coefficients are very similar ranging from 0.94 for the GARCH models to 0.96 for the linear regression models. However, further analysis shows a marked improvement in the $\overline{R^2}$ values from 0.00% to 12.8% as well as a p statistic that supports the accuracy of the GARCH (1, 1) model at a very high confidence interval. Overall, the GARCH model presents a better fit than the linear regression model.

NSEIRetA	Linear Regression	GARCH (1,1)	GARCH (10,1)
Adj R²	0.47%	-0.49%	-6.91%
f	2.41	0.70851	(z) -1.5280
p	0.12	0.61745	0.1265
TIC	0.91		0.93
Goodness of fit	Weak $\overline{R^2}$ Moderate p-statistic	Weak $\overline{R^2}$ Weak p-statistic	Strong $\overline{R^2}$ Moderate p-statistic
Status	Poor Fit	Poor Fit	Good Fit

Table 20

The $\overline{R^2}$ value increases as you move from linear regression to GARCH (10, 1). The TIC statistic also improves as you go to the GARCH (10, 1) model. The GARCH (10, 1) model gives the best fit with a strong adjusted R squared, a moderately strong p statistic and a strong TIC.

AllRetnA	Linear Regression	GARCH (1,1)	GARCH (10,1)
Adj R ²	0.24%	5.77%	-5.15%
f	0.74	4.6528	(z) 0.6560
p	0.39	0.000421	0.5118
TIC	0.95	0.78	0.87
Goodness of fit	Weak $\overline{R^2}$ Poor p-statistic	Strong $\overline{R^2}$ Strong p-statistic	Strong $\overline{R^2}$ Poor p-statistic
Status	Poor Fit	Good Fit	Average Fit

Table 21

The Theil Inequality Coefficient deteriorates significantly as you move from the linear regression model to the GARCH model. However the $\overline{R^2}$ statistic improves from 0.24% for linear regression to 5.77% for GARCH (1, 1). Overall the best model is still the GARCH model.

SUMMARY OF OLS REGRESSION RESULTS AGAINST GARCH RESULTS			
Market Segment	OLS Adj R-Sq	GARCH Adj R-Sq	Technique with superior explanatory power
AllRetnA vs. TBills Rate	0.0%	5.15%	GARCH
AgrRetA vs. TBills Rate	1.7%	-8.75%	GARCH
ComRetA vs. TBills Rate	0.0%	-4.96%	GARCH
NSEIRetA vs. TBills Rate	0.1%	-6.91%	GARCH
FinRetA vs. TBills Rate	0.0%	8.1%	GARCH
IndRetA vs. TBills Rate	0.0%	12.8%	GARCH

Table 22

The above results indicate that GARCH has greater explanatory power than OLS linear regression. This is consistent with Asset Pricing Models of CAPM and APT which indicate that the risk free rate, practically interpreted as the prevailing T-Bill Rate of the day is a key factor in the return of assets on the NSE. This is also consistent with the fact that GARCH does not cancel out the “error” term “noise” but fully embraces it to capture the impact of previous volatility and variance into present observations.

INTERPRETATION OF GRAPHS

Information from the graphs showing the trends of the various market segment returns from the period April 1996 until December 2001 indicate that they respond to the TBill rate in a consistent fashion. The plot of TBills Rate over time was used to isolate key points in time

where the TBills Rate was experiencing marked increases or decreases. A period of 4 weeks before and after the high (low) point was then taken as a cut off. These points were then used to analyze the trends of the various market segments to see how they responded.

The increase in the TBills Rate has a greater impact on the market than a decrease in the TBills Rate. Increases are marked with significant drops in the returns of all market segments, which persist for several weeks. Periods where the TBills Rate is steadily increasing are marked by dismal performances in most market segments. Periods where the TBills Rate decreases are marked by a short lived increase in market segment returns. Generally the effect on the various market segment returns is instantaneous, but on a few occasions certain market segments take a week to register the change in their overall returns. A few examples showing the nature of the response are illustrated in the graphs below.

Effect of TBills Rate Drops from a High of 24.32 to 22.32 on Other Market Segments

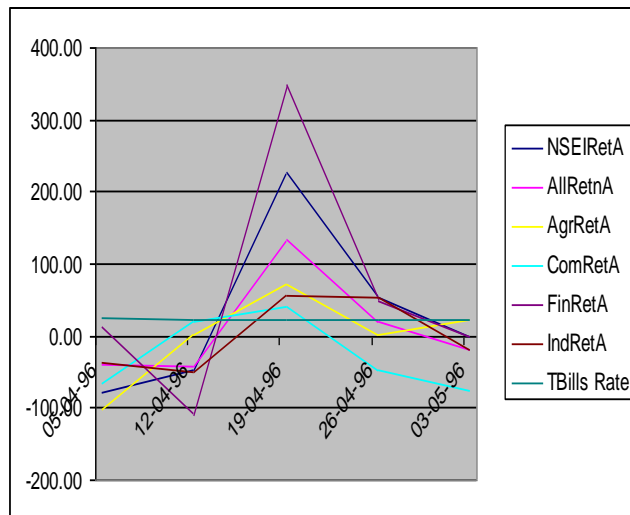


Figure 1

Effect of TBills Rate Drops from a High of 21.92 to 21.20 on Other Market Segments

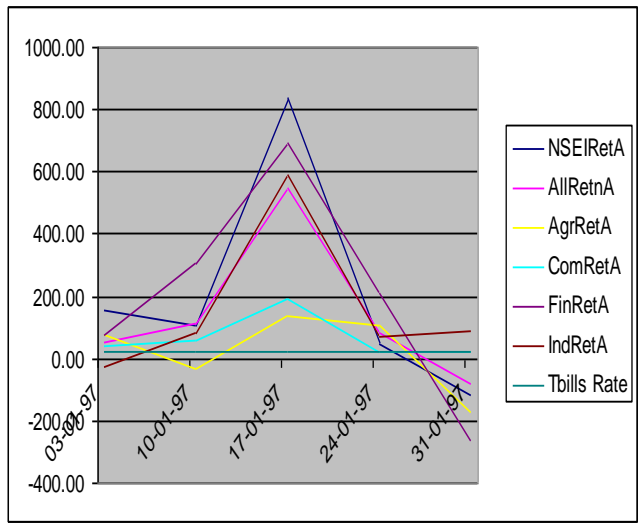


Figure 2

Effect of TBills Rate Increase from a Low of 19.20 to 21.45 on Other Market Segments

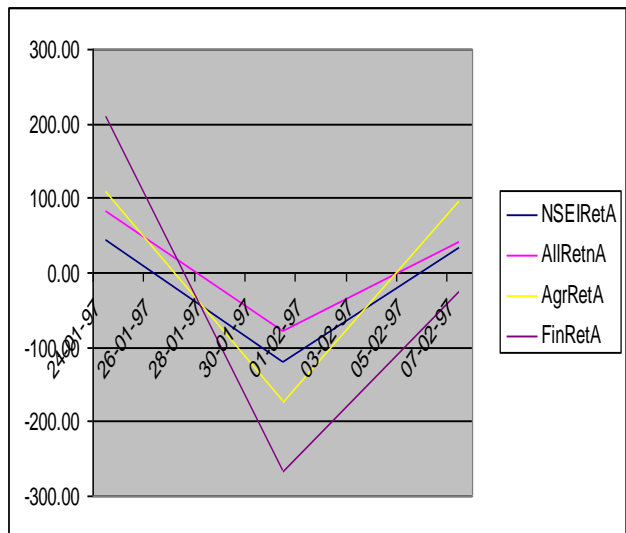


Figure 3

DATA INTERPRETATION AND ANALYSIS

Restrictive Money Policies and Market Returns

In keeping with finance theory this study finds that there is a relationship between the T-Bill rate and the return of stocks on the NSE. During times of restrictive monetary policy - or rising interest rates – the study found that markets performed poorly, resulting in lower than average returns and higher than average risk. Conversely, periods of expansive monetary policy - when interest rates are falling - generally coincide with strong stock performance including higher than average returns and less risk. One of several examples is the period from 21st June 1996 when the T-Bill rate rose from 21.93 to a maximum of 24.41 on the week of 27th September 1996. During this period the average of the NSE -20 Index dropped from a weekly average of 35.73 to a weekly average of -3.64. The returns of other market segments were equally depressed and are shown in the summary below.

MARKET SEGMENT RETURNS BEFORE AND AFTER A TBILL RATE INCREASE (21 st June 1996 to 27 th September 1996)				
Item	Sector	Average return before the increase of TBills Rate	Average return after the increase of TBills Rate	Difference in Average Return over the period
1.	Agricultural Sector	7.33	3.71	3.62
2.	Financial and Investment Sector	45.33	-26.46	71.79
3.	Industrial and Allied Sector	26.60	-17.68	44.28
4.	Commercial and Services Sector	-4.78	3.90	-8.68
5.	All Market Returns	21.44	-8.40	29.84

Table 23

The summary above shows that with the exception of the Commercial and Services Sector, all other sectors reported a decline in returns. In addition, certain sectors are much more sensitive than others to changes in T-Bill rates. The Financial and Investment Sector is more sensitive, reporting a change of approximately 72 points and the agricultural sector is least sensitive reporting a change of 3.62 points. In addition, an upward trend in asset prices is accompanied by an expansion in credit in an economy as it adds to the value of collateral, strengthens the borrowing capacity of investors and the lending propensity of banks. However if this expansion is not based on realistic expectation of future prospects, a financial bubble occurs. During the period from 25th July 1997 to 17th July 1998, the average T Bill Rate decreased from an average of 25.90 to 13.97 with an all time high of 27.20.

MARKET SEGMENT RETURNS DURING PERIODS OF SUSTAINED TBILL INCREASES AND TBILL RATE DECLINES				
item	sector	Average return during the period of increasing T Bill Rate	Average return during the period of declining T Bill Rate	Difference in Average Returns
1.	Agricultural Sector	25.75	11.26	-14.49
2.	Financial and Investment Sector	-12.25	24.80	37.05
3.	Industrial and Allied Sector	-5.78	36.83	42.61
4.	Commercial and Services Sector	4.95	28.74	23.79
5.	All Market Returns	7.98	31.74	23.76
6.	NSEIRetA	6.47	28.05	21.58

Table 24

The above table summarizes the returns during these periods and indicates that all sectors with the exception of the agricultural sector showed a marked improvement in performance with the Industrial and Allied Sector showing a marked sensitivity to the rates, closely followed by the Financial and Investment Sector.

Turbulence in the Economy

When financial markets move from normal to turbulent periods, credit and liquidity premiums both tend to increase substantially as potential purchasers of security assets become more averse to risk and seek a "safe haven" in instruments such as Treasury bills. "safe" options may include the commercial and services sector which is offer stability in Fast Moving Consumer Goods (FCMG) e.g. Uchumi Supermarkets Ltd.

Periods of Stability

It is noted above that increase in TBills Rate has a greater effect on the market than periods of TBills Rate decrease. During these periods, the returns of various market segments tend to exhibit a trend rather than hop from negative to positive, from high to low. Even during periods of steady increase of TBills rates the same is observed. Such periods of continuous TBills Rate increase or decrease can be termed as "stable" circumstances and could probably explain much of the behavior of T-bill interest rates against the prices of assets on the NSE. When monetary policy becomes progressively more stable - the base rate becomes less volatile compared with the past, and the CBK provides more information so that market participants can anticipate changes in policy. With less volatility, overall liquidity and credit-risk premiums may have dropped, thus narrowing the myriad differences in the returns of securities on the NSE.

Changes in Minimum Reserve Requirements

The reserve requirement is the amount of money that a depository institution is obligated to keep in the CBK vaults in order to cover its liabilities against customer deposits. The Board of Governors decides the ratio of reserves that must be held against liabilities that fall under reserve regulations. Thus, the actual shilling amount of reserves held in the vault depends on the amount of the depository institution's liabilities. The Kenya Letter of Intent, Memorandum of Economic and Financial Policies and Technical Memorandum of Understanding from the Kenyan Government to the IMF in December 2004 notes that "The easing of monetary policy in 2003/04 to support economic recovery resulted in declining interest rates and rising inflation. Following the reduction in the legal reserve requirement from 10 percent to 6 percent in July 2003, the reserve money multiplier rose from 4.9 to 5.3,

resulting in a 13 percent expansion of broad money in 2003/04 against the 7 percent projected under the program. The consequent rise in liquidity led to negative real yields on money market instruments. In response to the decline in interest rates, bank credit to the private sector grew substantially. This was also the case from September 1997 to June 1998 when the minimum reserve requirement ratio dropped from a minimum of 15% to a minimum of 12%. This also happened in September 1998 when the ratio dropped from a minimum of 14% to 10%. This may account for the lack of consistency in the behaviour of the returns of the assets when examined solely in the light of T-Bills Interest Rate. The table below briefly summarizes the changes in minimum reserve requirements ratio over the years in Kenya.

RESERVE REQUIREMENTS RATIO			
1990 to March 1993	Daily minimum	6%	fixed
April and May 1993	Daily minimum	8%	fixed
June - September 1993	Daily minimum	10%	fixed
October -November 1993	Daily minimum	12%	fixed
December 1993 - January 1994	Daily minimum	14%	fixed
February -March 1994	Daily minimum	16%	fixed
April - July 1994	Daily minimum	20%	fixed
August 1994 - April 1996	Daily minimum	18%	fixed
May 1996 -September 1997	Minimum 15%	18%	Average over 14 days cycle.
October 1997 - June 1998	Minimum 12%	15%	Average over 14 days cycle.
July - September 1998	Minimum 14%	14%	Average over 14 days cycle.
October - November 1998	Minimum 10%	13%	Average over 14 days cycle.
December 1998 - November 2000	Minimum 9%	12%	Average over 14 days cycle.
December 2000 - June 2003	Minimum 8%	10%	Average over 14 days cycle.
June 2003 to date	Daily minimum	6%	Fixed, include foreign currency deposits

Table 25

Mwega (2005) notes that many financial systems in Africa have been subjected to financial repression characterized by high reserve requirements (sometimes of 20%- 25% compared to 5%-6% in developed countries). This in turn leads to high spreads thereby imposing an implicit tax on financial intermediation. This financial repression gives the government and

public sector preference and crowds out the private sector, resulting in inefficient allocation of funds within the economy.

Government Fiscal Policy

When the Government increases rates, it is seeking to restrain the economy. Companies that borrow money pay more when interest rates go up. This reduces their earnings and in turn reduces their attractiveness to potential investors. As a result, the price of securities on the NSE will fall. (See Table 23 and Table 24). Further more consumers also pay more to borrow money, which discourages them from buying cars, houses and everything that goes with them. This hurts companies dependent on the consumer.

Risk Profile of Investors

Since investors care about expected yields and not promised yields, they demand a higher rate of return on private money securities than on Treasury Bills in order to offset the perceived risk of default and to equalize expected returns. The higher the default risk premium is for a particular asset, the less attractive it may be for a conservative investor. During periods when the Treasury bill interest rate is high conservative investors may view this as an attractive investment as opposed to putting their money in private securities. This then would starve the stock market of much needed funds and result in dismal performance within the Nairobi Stock Exchange (See Table 23 and Table 24).

SUMMARY OF FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

This study presents the analysis of TBills Rates and their impact on the return of assets on the Nairobi Stock Exchange. The tests for ARCH were positive for all market segments with the exception of the Financial and Investment Sector and the Commercial and Services Sector. The conclusions drawn are:

1. The Treasury Bill Rate has a significant impact on the asset returns of the various market segments, the NSE – 20 Share Price Index and All market returns as a whole.

2. The behaviour of the returns of assets on the NSE can be better explained by considering the volatility of previous periods. This is modeled using the ARCH term within the GARCH analysis.
3. The study found that GARCH analysis gives a better explanation for the relationship between Treasury Bill Rates and asset returns than linear regression in every market segment.
4. The study found that further iterations using ARCH terms from previous periods produced a better fit than the GARCH (1, 1) model.

RECOMMENDATIONS

The Government of Kenya should seek to implement more effective public debt management strategies so as to achieve desired fiscal and monetary objectives without adversely affecting the prices of assets on the NSE. A balance between legislation, control and market forces should be encouraged to ensure that there is effective allocation of resources within the economy to promising companies. The study has shown that the return of assets in the Industrial and Allied Segment can be accounted for by the T-Bill Rate to the extent of 12.8%.

If the Government is serious about attaining Industrialization status by 2020 they should put in place structures that create an enabling environment for the Industrial and Allied Segment to thrive. Some of these structures will require the review of T-Bill Rates.

Since GARCH produces more reliable results for a data sample of 1000 and greater, it would be advisable to carry out the same analysis using a longer time period and compare the results with the current ones. The data indicated periods where there was a sharp transition within the data. The use of Smooth Transition GARCH (STGARCH) to analyze the data may offer a model with stronger explanatory capabilities.

LIMITATIONS OF THE STUDY

The study used rudimentary GARCH analysis and hence did not take into consideration several options that could be utilized to create a better fit forecasting model. In particular,

the study was not able to design mean models and variance models that had been refined using appropriate regressor variables.

GARCH models are useful but only part of a solution. Although GARCH models are usually applied to return series, financial decisions are rarely based solely on expected returns and volatilities. There is a need to map the activity of these returns along side other economic indicators in play during the period under study. These economic indicators would give a better overall picture of the model and would include rate of taxation, inflation, unemployment, the level of foreign exchange reserves, the impact of IMF programs on the country etc. GARCH models have shown greater consistency in results for a range of data greater than 1000. Our study employed a total of 299 data samples and this would probably account for the negative adjusted R squared values.

Previous studies on predicting the returns of assets on the NSE using various factors and OLS regression could benefit from analysis using GARCH. It was observed in the Literature Review Section, that most of these studies yielded results that were statistically insignificant, inconclusive or lacking in explanatory power. The use of GARCH may shed light on the analysis and produce results that better reflect theory.

RECOMMENDATIONS FOR FURTHER STUDY

GARCH analysis is a relatively new approach to the modeling and examination of financial time series especially within Kenya. Probability distributions for asset returns often exhibit fatter tails than the standard normal distribution. The fat tail phenomenon - excess kurtosis, as well as the characteristic volatility clustering of residuals is found within asset returns and is best modeled by GARCH. Studies to promote the understanding and utilization of the various types of GARCH should be undertaken for clearer interpretation of market data. Other GARCH Models to be utilized in the advanced interpretation of the data include STGARCH - Smooth Transition GARCH, IGARCH – Integrated GARCH, and TGARCH – Threshold GARCH.

The analysis of the relationship between TBills Interest Rate and the return of assets on the NSE could also benefit from analysis using a larger data set of more than 299 observations. This is because GARCH has been shown to be more effective when the data set is greater than 1000.

It would also be beneficial to undertake GARCH analysis on studies that examine more than one independent variable. This would give a clearer picture and help isolate the key variables within the economy that affect prices of assets on the NSE. The more the number of variables analyzed the greater the predictive power of the model. Other variables to be considered would include inflation, exchange rate of the Kenya Shilling against the dollar or Euro, and level of government debt.

This study focused on the utilization of the ARCH term while holding the GARCH term constant at 1 lag. Future studies would benefit from an examination of the effect of GARCH term as the number of lags is increased. A comparison between the predictability power of using both the ARCH term and the GARCH term should be done against the use of only the ARCH term and a recommendation made for the best analysis criteria.

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