A Test of the Effect of Macro-economic Variables on Volatility of Securities Prices: Evidence from Nairobi Securities Exchange

Konyango Griffin Okoth
konyangojeff@rocketmail.com,
or Griffin.Konyango@cic.co.ke
and
Barasa, Joseph Lumumba
jbarasa@uonbi.ac.ke
or lumbajobarjolu@yahoo.com)

Abstract

Volatility as an erratic rise and fall in the stock returns with a lot of demerits especially when it comes to valuation of equities at the stock exchange in that it may cause the bourse to value the securities incorrectly. All it may act as a cold shoulder to investors confidence due to increased uncertainty and hence risk which subsequently may lead to limited investment as a result of the high capital cost emanating from high premium, demanded by shareholders in their investment. This will eventually lead to a slow growth and development of an economy. The main objective of this study is to establish the effect of macroeconomic variables on volatility of securities prices in the Nairobi Securities Exchange (NSE). To achieve the objective of the study, models were developed using annual inflation rate, exchange rate, interest rate, money supply, broad money supply and general money supply as the independent variables and the stock returns as the dependent variable.

An empirical analysis was conducted using Nairobi Securities Exchange (NSE) listed firms as the population. The period of analysis was 22 years from 1st January 1990 to 31st December 2011 on an annual basis. The correlation results reveal that exchange rate (EXR) has the highest negative impact on volatility of security prices, whereas inflation rate (INF) had the lowest marginal impact and/ or effect on volatility of security prices. Moreover, interest rate (INT) had a significant, negative impact on volatility of security prices. Others such as general money supply (GMS), money supply (M3) and broad money supply (M3X) had a higher positive effect on volatility of security prices. In our empirical analysis, by employing the EGARCH and TGARCH model we were able to deduce that the level and/ or degree of volatility persistence, volatility magnitude and leverage effects to be in existence at the NSE but varied in terms of significance of the shocks impact on stock volatility, of each of the selected macroeconomic variables. However, collective impact was significant.

Key words: *Volatility of securities, macro-economic variables, Nairobi Securities Exchange, EGARCH and/ or TGARCH*

PART I

INTRODUCTION AND RESEARCH OBJECTIVES

1.1 Background of the Study

1.1.1 Macroeconomic Instability

Macroeconomic instability which is as a result of supply and demand shocks in an economy is observed using key macroeconomic indicators such as inflation rate, interest rates, exchange rate, money supply, balance of payments among others; influence the valuation of securities in terms of risk premium hence the cost of capital which influence stock prices. Like a

business cycle an economy also experiences fluctuations with various economic variables and hence, characterized by periods of a peak, recession, trough and recovery which influence the frequency and magnitude of stock price movements. Evidence of instability in the macroeconomic indicators can be derived from the dynamics in exchange rates, growth of money, government fiscal deficits, lending rates, exchange rates and inflation rates (RBZ Annual Report, 2003).

Investor expectations are influenced by exogenous uncertainty forces that are external to the economy and are related to information on various macroeconomic variables which influence their decisions on investment. Hence they add to stock exchange volatility. Whereas under Rational beliefs, endogenous and exogenous uncertainty influenced by news related to or not to fundamentals influence investors beliefs, to hold, sell, repurchase more securities thereby exaggerating stock market volatility. Investors update their expectations and beliefs with great frequency as new information become available, which basically occurs around the clock (Kurz, 1997).

1.1.2 Stock Market Volatility

Stock exchange volatility, the constantly changing of equity prices is as a result of investors' expectations and beliefs. Rational expectations posit that investors input all available relevant information that make logical sense given what is known at any particular moment into the best forecasting model available. Hence expectations will be the best guess of the future using all available information provided it is not irrational in that it did not logically follow from what is known or if it ignored available news, especially, related to macroeconomic variables. Expectations, rather than eventualities, moved equity prices, thus expectation of an event creates a much deeper impression upon the bourse than the event itself therefore people invest based on what they believe the future will bring, not on what the past and/

or the present brings, even though they often look to the past, present and even the distant past for hints about the future (Vega, 1688).

Rational beliefs theory on the other hand posit that stock exchange uncertainty is as result of endogenous uncertainty. It is a component of price volatility that is caused by the distribution of beliefs of the investors and exogenous uncertainty as a component of stock market volatility which is determined by the volatility of the exogenous fundamental conditions in the stock exchange. Therefore, endogenous uncertainty has a dual effect on market volatility in that the distribution of beliefs in the stock market cause fundamental news to have a larger effect on stock price volatility than would be true in a corresponding rational belief equilibrium where investors have homogenous, correct, beliefs. Secondly, endogenous uncertainty arising from variations in distribution of beliefs but unrelated to any fundamental news causes additional stock price volatility. For instance, when a large mass of investors become optimistic about capital gains, equity prices may appreciate, whereas when a similar mass of market participants become pessimistic about the stock exchange future prospects, equity prices decline (Kurz, 1997).

1.1.3 The Effect of Selected Variables on Stock Exchange Volatility

Stock exchange volatility is linked with macroeconomic variables through the standard share valuation model, since in this model, equity prices reflect changes in the discount factor which incorporates the risk free and risk premium components as well as expected dividends. To come up with the discount factor one has to consider the riskiness of the macroeconomic environment, in which case a highly unstable macroeconomic environment would lead to frequent changes in equity valuations and hence volatile equity prices whereas a stable macroeconomic environment would result in less dynamism in the equity valuations and hence stable equity prices (Muth, 1961).

Therefore, the link between bourse efficiency and volatility lies in the fact that efficient equity prices and yields provide a benchmark against which the cost of capital for and returns on investment projects can be judged. Hence, depending on the number, size, influence, correlation and how investors evaluate their macro and microeconomic environment either under the influence of their expectations and/ or beliefs in relation to news related to or not to fundamentals, this would determine the rate of return required from investment. Hence here would be the risk premium, the cost of capital and subsequently, equity price, which would eventually contribute to stock exchange volatility (Kurz, 1997).

1.1.4 An Overview of the Nairobi Securities Exchange

The NSE has a long history that can be traced to the 1920s characterized by informal share trading with no formal rules or regulations to govern trading activities. Thus, trading in equities was mainly based on gentlemen's agreement whereby a standard commission was charged and clients were required to respect their contractual commitments of making good delivery and settlement of costs (IFC/CBK, 1984).

The desire to establish a formal market was initiated by stock brokers who desired to have a bourse that facilitated access by private enterprises to long-term capital. Moreover, the minister of finance by then, desired to have a formal bourse that would facilitate floating of locally registered government loans, which would be unattractive without the bourse resulting in constitution of the Nairobi Stock Exchange in 1954 as a voluntary association of stock brokers registered under the Society Act (NSE, 1997).

To effectively facilitate registration, stockbrokers obtained clearance from the London Stock Exchange (LSE), which recognized the Nairobi Securities Exchange (NSE) as an oversea stock exchange. This effectively enabled the Nairobi Securities Exchange (NSE) to gain credibility, value as well as prominence. For it was charged with the responsibility of

developing and regulating trading activities. Hence, a self regulatory framework, which was heavily borrowed from London Stock Exchange (LSE) was embodied in the Nairobi Securities Exchange (NSE) 1954 regulations and rules (Munga, 1974).

In order to cater for specific needs of different issues, the Nairobi Securities Exchange (NSE) established three segments that are the Main Investment Market (MIMs), the Alternative Investment Market (AIMs), the Fixed Income Securities' Market (FISMs) and the Future and Option Market (FOMs). On November 10th 2004, the Nairobi Securities Exchange (NSE) inaugurated operations of the Central Depository System (CDS) which would revolutionalize the bourse as traders would not suffer more from problems of fake shares, long settlement cycle and operational inefficiencies, engrained in manual clearing and settlement thereby enhance investor confidence and create a smooth transition into an electronic based settlement and registry (NSE handbook, 2002).

Since the bourse is a market that facilitates exchange of shares of publicly quoted companies, municipals and government securities, it is a place where investors register their opinion on the future of the economy (Inanga, and Emunga, 1997). According to the Nairobi Securities Exchange handbook (2002), activities in the bourse serve as indicators and/ or parameters of the economy as equity prices tend to appreciate or stabilize when the economy and relevant companies such as blue chips are stable and growing.

The stock exchange assists in the transfer of savings to investment in productive enterprises. It promotes a culture of thrift, and it assists in rational and efficient allocation of scarce resources such as capital. It provides flexibility to customization by improving access to finance to wide variety of users and lastly, it provides investors with efficient means and/ or mechanism to liquidate their investments in equities (Kibuga, 2002).

1.2 Research Problem

The relationship between various macroeconomic variables and equity volatility has been of significant concern in the financial world, since the bourse plays a significant role in evaluating the economic conditions of a country, as it plays' a central and crucial role, as well as acting as a catalyst in fast tracking the growth and development of an economy, by establishing an environment that is conducive and favourable for investment, in that both foreign and local investors are able to obtain equity finance as start-up capital as well as expand the already operating business by trading in various kinds of securities. Equity prices significantly influence the performance of an entire economy in that efficient equity prices and yields provide a benchmark against which the cost of capital for and returns on investment projects can be judged. Therefore achieving stability in the equity prices is ideal for the proper pricing of financial assets whereas in case of perceived increase in risk, a well functioning bourse is supposed to reward investors who take on or assume higher risk without distorting the efficient allocation of resources by making investors more averse to holding equity, since risk averse investors will tend to demand a higher risk premium which will increase the cost of capital, thereby hindering the level of investment and ultimately slowing down economic growth. Therefore, attaining efficiency in the stock exchange reduces volatility of equity returns which would subsequently lead to efficient allocation of capital (Ngugi, 2003).

There is significant study on stock exchange volatility in developed economies. This can be observed in the works of Porteba and Summers (1986), and French et al., (1987) who related stock market volatility to the volatility of expected returns. Maysamikoh (2000) and Choi et al., (1992) examined the impacts of interest rate and exchange rate on the stock returns and showed that they were determinants in the stock price volatility.

In developing economies especially Kenya the study is deficient and skewed as can be seen from a few literature. Ngugi et al., (2003) analysed the impact of reforms on volatility, efficiency, cost of trading and liquidity for the period 1988:01 to 1999:12 using GARCH-type model for over 10 bourses in Africa. Achia, Wangombe and Anyika (2008) carried out an empirical study of the impact of political climate on stock exchange volatility. Nyamongo and Misati (2010) investigated the relationship between stock volatility and returns in the Nairobi Securities Exchange (NSE).

Most of these studies particularly, Kenyan studies have not taken into account the effect of selected variables as well as the influential role they play in shaping investors' expectations and beliefs that subsequently play a contributory and propagating role to the volatility of equity returns in the stock exchange. This study intends to fill this gap by answering the question: "What is the effect of macroeconomic variables on the volatility of security prices in the Nairobi Securities Exchange?"

1.3 General Objective

The objective of this study is to establish the effect of macroeconomic variables on the volatility of security prices in Nairobi Securities Exchange (NSE).

1.4 Specific Objectives

1. To establish the effect of exchange rate fluctuations on volatility of securities prices in Nairobi Securities Exchange;
2. To establish the effect of interest rate fluctuations on volatility of securities prices in Nairobi Securities Exchange;
3. To establish the effect of inflation rate fluctuations on volatility of securities prices in Nairobi Securities Exchange;

4. To establish the effect of general money supply fluctuations on volatility of securities prices in Nairobi Securities Exchange;
5. To establish the effect of money supply fluctuations on volatility of securities prices in Nairobi Securities Exchange; and
6. To establish the effect of broad money supply fluctuations on volatility of securities prices in Nairobi Securities Exchange.

1.5 Research Hypothesis

1. Exchange rate fluctuation has no significant effect on volatility of securities prices.
2. Interest rate fluctuation has no significant effect on volatility of securities prices.
3. Inflation rate fluctuation has no significant effect on volatility of securities prices.
4. General Money supply fluctuation has no significant effect on volatility of securities prices.
5. Money supply fluctuation has no significant effect on volatility of securities prices.
6. Broad money supply fluctuation has no significant effect on volatility of securities prices.

1.6 Significance of the Study

Knowledge from this study is considered to be important to the following groups: To potential investors who may be individual, institutionally local and/ or foreign based, the study will reveal to them whether or not the NSE 20 share index has been able to efficiently price its equities, especially

during periods of macroeconomic instability. Equity prices reflect expectations about future corporate performance, thus, lower or enhance their confidence and/or participation in the stock exchange activities.

To the Ministry of Finance, the study will highlight, weigh merits and demerits of application. For example, monetary and fiscal policies by the Central Bank of Kenya (CBK) in taming shocks to macroeconomic variables such as inflation, interest rates, exchange rates, money supply and balance of trade among others. Hence it will give wise counsel to the government on effects of its macroeconomic policies in taming macroeconomic instability which may inadvertently depress the stock market and curtail capital formation that will itself lead to further slow down of the economy.

To Academicians, the study will add to the body of knowledge about the stock exchange and hopefully form a basis for further research, especially in the use of other modern versions of the GARCH-type models in capturing and comparing the results about the asymmetric, as well as the symmetric nature of equity returns.

PART II

THEORETICAL BACKGROUND AND INFORMING LITERATURE

2.1 Introduction

This chapter explores reviewed theoretical and empirical literature related to macroeconomic variables and stock exchange volatility. It includes rational expectations and rational beliefs theories, thereafter concluding by reviewing empirical literature.

2.2 Theoretical Literature Review

2.2.1 Theory of Rational Expectations

Muth (1961) stated that, "Rational expectation is a simultaneous determination of people's behaviour which produced a time series and a time series which led people to form expectations that affected their behaviour." Hence, investors action depend on their expectations which eventually affect equity price level. Investors expectations are the best guess of the future using all available information that is mostly based on macroeconomic variables such as unemployment, inflation, interest rate, money growth, exchange rate and monetary aggregates among others. Rational expectations equilibrium (REE) be a situation whereby every investor's action is based on expectations regarding the other investors' action as well as expectations regarding the nature of the state in terms of stability or instability of the macroeconomic variables and whether these expectations turn out to be true will have an influence in the movement of equity prices. That is especially when there is a positive or negative correlation consensus in the expectations of a large number of investors towards true certain equity in the stock exchange (Muth, 1961).

Expectations to be in general equilibrium, availability of news in all stock exchanges should be consistent. Investors need to act on the same beliefs when purchasing, selling and increasing or decreasing their cash balances and consumers make investment decisions based partially on their expectations of future stock prices (Lucas, 1972).

Expectations being of two forms, weak-form expectation whereby no restriction is placed on news and/ or information in that whatever information people have they make maximum use of it in forming their expectations. Under strong-form rational expectation, contents of an investor's information set are placed under strong restriction even though people have access to all relevant available information about the structure of their

environment. Hence, in forming their expectations, they maximize such information on various capital and/ or resource investing decisions (Muth, 1961).

People invest in the bourse based on what they believe the future will bring, not on what the present brings or the past has brought, even though they often look to the present and past for clues about the future. Since investors have strong incentives to make rational forecasts they would act accordingly, whereas if their expectations are consistently wrong they will re−formulate the expectations model to include other variables. Thus, influence the level of equity prices. Rising inflation would lead to a rational conclusion that the Central Bank of Kenya (CBK) will engage in a restrictive monetary policy to reduce inflationary pressure which will ultimately influence equity price volatility (Vega, 1688).

Assumptions of rational expectations theory according to Kurz (1997) is that, "Investors know the true probability law underlying the equilibrium variable of the economy; they also know the supply and demand functions of all other investors thereby they compute equilibrium prices of assets and commodities in the future and in the present given any possible external fundamental news and/ or information in the future; and lastly the true probability law of the economy is not moving in that all the joint probabilities of economic variables are constant as one moves the time scale. In summary the stock market volatility is caused by forces that are external to the economy called exogenous uncertainty, hence no financial risk can be propagated from within the economic system via human actions or beliefs hence the volatility of equilibrium variables is similar to the level that would be justified by the volatility of the exogenous conditions"(Kurz, 1997).

According to Arrow (1978) and Tobin (1980), "the expectations assumptions are inconsistence with observations in that aggregation is neglected, everyone having the same access and/ or information at the same cost, non existence of forward markets for all contingent claims,

differences in tastes and opportunities. It does not describe the way investors think about their economic environment, how they learn, and process information; therefore it is like a property that is likely to be approximately possessed by the outcome of unspecified process of learning through adaptation". It could not explain observed cyclical correlations such as the positive correlation between aggregate outputs and equity price that is the outputinflation trade off (Lucas, 1978).

Kerem et al., (2003) tested for expectations that were rational by treating the rationality of expectations as financial rationality using the time series properties of inflation in getting the forecasting model. Using theoryfree testing based on assumption of linear expectations and random walk of monthly changes of consumer price index (CPI), their objective was to test for the applicability of rational expectations hypothesis in macroeconomic models of Estonia. Their autocorrelation and Q-Statistics showed that the consumer price index (CPI) moving towards standard financial rationality, whereas change in the time structure of interest rates supported rational expectations hypothesis.

Theory of rational expectations is of paramount to our study. It is a collection of assumptions regarding the manner in which investors exploit available news and/ or information mostly based on macroeconomic variables to form their expectations regarding future prospects of equity returns thereby causing stock volatility.

2.2.2 Theory of Rational Beliefs

Kurz (1974) developed the theory of rational belief due to limitations of rational expectations, by offering a strong, clear, realistic as well as an in depth view without any bias and/ or contradiction of a unified view of stock exchange volatility by explaining that fluctuation in equity price is as a result of two components, one being by the effect of endogenous uncertainty which is as a result of variation in distribution, correlation and/

or commonality of beliefs of investors which is unrelated to any fundamental news; and the exogenous uncertainty that emanates from fundamental forces in the external economy is amplified by endogenous uncertainty, but both endogenous and exogenous uncertainty play a significant role in influencing investors beliefs of whether he or she should hold, sell or purchase more shares thus affect volatility of equity return.

According to Kurz (1997) concept of "Endogenous Uncertainty", holding of wrong beliefs results in making "mistakes," "the mistake of an investor at date x, defined as the function which describes the difference between the collection of his forecasts at date x conditional upon the information at that date and the forecasts that would be made with the correct model, were it known. Since an investor selects his decisions for instance a portfolio of investments based on his beliefs, these mistakes in beliefs get transformed into mistaken actions. In an equilibrium state, equity prices and quantities will reflect those mistakes. Thus, mistakes in assessment of market values result in incorrect aggregate valuation of financial instrument by the stock exchange. The equilibrium stock exchange price may rise above exogenous fundamental values when asset prices appreciate and fall southwards when asset prices plummet, thus an important component of the economic variables; volatility emanates from forecasting mistakes of investors which arise from the variability in the states of beliefs of investors" (Kurz, 1997).

That component of volatility of the variables that is beyond and on top of the level that would be justified by the exogenous variables of the system is said to be "internally propagated," and hence, "endogenous uncertainty." Thus, the theory of rational beliefs is based on the premise that diverse but rational beliefs propagate stock exchange volatility. Under rational belief equilibrium, investors make use of realized equity prices and news in determining their future state of beliefs. Moreover, the distribution of beliefs and differences in equity prices may be dependant upon the correlation of

consensus among the investors' models and information based on fundamentals as well as realized equity prices. Therefore, abrupt/ and or sudden change of either is subsequently followed by an immediate change of the induced regime of investors' beliefs" (Kurz, 1974).

According to Kurz (1994) news and/ or information about some macroeconomic fundamental fact will often cause a greater equity price change than the news would be able to justify. This is due to the reason that rational beliefs are correlated and are not usually random because investors, talk and listen to each other. Also they read the same newspapers, magazines, journals, and even watch and listen to the same programs from the media.

Assumptions of rational beliefs theory, according to Kurz (1994a, 1994b) are, "Investors do not know the true probability law underlying equilibrium magnitudes, and in general they do not know the map from external variables to equilibrium quantities specifically in equity prices, however they have access to a very large volume of all historical data on the performance of the economy which they can use to statistically test any theory which they may develop about the financial markets and the functioning of the economy, hence investors are able to learn something about the structural correlations in the economy.

Finally, although the economy of a country may undergo structural dynamics yielding non-static state, the economic universe remains stable in the sense that quantitative and statistical analysis can be successfully carried out in it. Hence, in such a system the concept of normal patterns makes empirical sense and provides useful knowledge reflected by long-term averages of economic variables. Therefore, although an economy experiences economic and technological dynamics the P/E ratios of major indices have well known normal ranges and long-term variances, means and covariances. Capital/output ratio, growth rates and interest rates, all have well known long-run average behaviour which reveals some important dimension of the true structure of a country's economy" (Kurz, 1994a, 1994b).

Kurz (1997) tested if equity prices strictly vary but not so much in accord with fundamental using a simulation model; variance of P/E ratio was bigger by an order of magnitude under rational beliefs than under expectations hence variance of equity price was dependant on distribution of beliefs which changes over time and causes a bigger variance of equity prices than the fundamentals. Comparison of the actual long term standard deviation of the return on Standards and Poor's 500 index (S&P) which was 18.4% with one simulated under beliefs of 17.5% and one simulated under expectation of 4.1%. Rational expectations had a higher volatility closer to actual S&P volatility.

Using a simulation model, Kurz (1997) tested the GARCH phenomena of time varying variance of equity prices which revealed presence of both the persistence in the states of belief of agents as well as correlation among these states. The GARCH phenomenon was as a result of shifts in the distributions of beliefs in the market induced by the dynamics of the individual states of beliefs. In explaining why the riskless rate is low and the equity premium is high and the riskless rate is high while the equity premium is low. It was found that at most dates there is a minority of pessimist investors who by the rationality of belief conditions have a higher intensity level of belief about high equity prices in future. Thus these agents push the riskless rate down and the equity premium up. In quantifying endogenous uncertainty as a component of aggregate stock exchange uncertainty, using the U.S stock exchange, at least 50% of the risk of one year excess equity returns and 64% of the risk of two year equity returns were internally propagated.

Theory of rational beliefs is limited in the sense that in a large economy consisting of many investors with independent beliefs, the law of large number would operate to average due to the diversity of beliefs of the investors hence such averaging renders the model of diverse beliefs, not only limited but irrelevant (Kurz, 1997).

Theory of rational beliefs provides us with an in-depth as well as a realistic view of stock exchange volatility by the inclusion of endogenous uncertainty component, which broadens our study on the real cause of volatility in the stock exchange.

2.3 Empirical Literature Review

Omet et al., (2002) carried out a study on the Jordanian Stock Exchange (JSM), to test for its efficiency and the relationship between conditional volatility and equity returns, by applying an autoregressive model of order one AR (1)-GARCH (1, 1)-M model estimated for five daily indices from January 1992 to December 2000.The estimated findings on efficiency showed a movement from efficient market hypothesis (EMH), whereby the two daily indices out of the five revealed a significant relationship between equity return and risk, and that all equity returns tend to exhibit high persistent volatility clustering, while the three daily indices were statistically insignificant.

A good explanation for the negative correlation between the level of inflation rate and equity returns is the proxy hypothesis by Fama (1981) which was later modified by Kaul (1987).This hypothesis states that the negative correlation is due to the negative correlation between future output growth and inflation rate. Since equity prices reflect corporate future earning potential, a decline in the economy predicted by a rise in inflation rate will make equity prices and returns to decline. The negative correlation between future output and inflation rate is explained by the negative correlation between real activity and inflation rate uncertainty and secondly the positive correlation between the levels of inflation rate uncertainty and inflation rate. Increase in inflation rate uncertainty makes future real earnings on investment more uncertain which subsequently reduces current investment and future output. Therefore, expected inflation rate representing the level of inflation rate implies that expected inflation rate is the underlying force that is correlated with future output and hence current equity returns.

Lee (1999) study on the proxy hypothesis used two different ways; the first consisted of parametric models in which the conditional variance of inflation rate and uncertainty premiums associated with them are non-linear increasing functions of expected and unexpected inflation rate. Using quarterly real returns and monthly data, his findings revealed that conditional variances are positively correlated with unexpected inflation rate. The same findings are also obtained from uncertainty premiums; hence both results support the hypothesis that the negative unexpected return correlation is driven by the negative uncertainty premium return correlation. The second approach avoids building parametric models for conditional variances but exploits the fact that frequency components of unexpected inflation rate can be used as indicators of varying degrees of inflation rate uncertainty. Regressions of real returns on frequency components of inflation rate with varying degrees of uncertainty reveal that the more the uncertainty associated with a frequency component the stronger the negative correlation with real equity return, thus supporting the hypothesis that the negative correlation between equity returns and the level of inflation is due to the negative correlation between future output growth and inflation rate.

Kearney and Daly (1998) discovered that the most important determinants of the conditional volatility of the Australian stock exchange were the conditional volatilities of inflation rate and interest rate which are directly associated with volatility of stock exchange and the conditional volatility of industrial production, the current account deficit and the money supply which are indirectly associated with the stock exchange conditional volatility; amongst these variables the strongest effect was found to be from the conditional volatility of money supply to the conditional volatility of the bourse.

Chinzara (2011) study of macroeconomic uncertainty and stock exchange volatility for Jordanian Stock Exchange (JSE), revealed that the volatility is significantly affected by macroeconomic uncertainty, whereas

financial crises increases volatility and that volatilities in interest rates, short term rates and exchange rates are the most influential variables in affecting stock exchange volatility whereas volatilities in inflation, gold prices and oil prices play insignificant roles in affecting volatility of the bourse.

A study of over 10 stock markets in Africa by Ngugi et al., (2003) analysed the impact of reforms on efficiency, volatility, liquidity, and cost of trading for the period 1988:2001 to 1999:2012. By applying the GARCH-type model to each individual bourse across the different markets before and after the reform exercise, the level of volatility being used as reflection of the level of foreign investors' participation in the bourse. Nairobi Securities Exchange (NSE) findings showed an insignificant decline in volatility following the entry of foreign firms whereas Nigeria Stock Exchange (NISE) showed a significant increase.

Nyamongo and Misati (2010) examined the relationship between stock volatility and returns in the Nairobi Securities Exchange (NSE) using daily equity returns data for the period January 2006 to April 2009.Their findings revealed that the equity returns are symmetric, leptokurtic hence not normally distributed, whereas the volatility of returns where found to be highly persistent, the leverage effect was insignificant and the impact of news on volatility was found not to be significantly asymmetric.

Nyamongo and Misati (2012) also carried out a study on the effectiveness of asset price channel in monetary policy transmission and the effect of stock exchange volatility on monetary policy in Kenya. Their findings revealed existence of the asset price channel of monetary policy transmission to be mixed in Kenya and the effect of monetary policy on equity price volatility to be insignificant, whereas stock exchange volatility creates instability in monetary policy variables, thus information from the stock market may be important in predicting the business cycle.

2.4 Synthesis

Theoretical explanation seem obvious at times while empirical results are always mixed and existing literature is inconclusive on the issue of expectations and/ or beliefs. Achieving stability in the security prices is ideal for fair pricing of financial instruments hence stabilizing the macroeconomic variables is expected to bring about stability in equity prices. Moreover instability in the macroeconomic variables or in case of increase in perceived risk, a well functioning stock exchange is supposed to reward investors who take on or assume a higher risk.

Empirical studies have shown that this is not always the case in developing stock exchanges, since few or non existent studies have been focused locally on the issue. This study will therefore aim at testing the effect of macroeconomic variables on the volatility of security prices in Nairobi Securities Exchange (NSE).

PART III

METHODOLOGY

3.1 Research Design

Research design is the plan and structure of investigating applied in obtaining answers to the study questions. It depicts the plan of investigation that is used to obtain empirical prove on the relationships as well as the structure of the problem (Cooper and Schindler, 2006).The study involved explanatory survey research design so as to unearth the impact and/ or effect of macroeconomic variables on the volatility of security prices in the Nairobi Securities Exchange (NSE). Explanatory survey was chosen for its robust study and in-depth search into the effect caused by six selected macroeconomic variables thus achieved the goal and purpose of this study.

3.2 Population of the Study

The population for this study consisted of all companies stocks listed at the Nairobi Securities Exchange (NSE) from which NSE 20 share index is derived from, the required data for listed stocks is readily available and that this population was appropriate. It gave a clear picture of the situation with inclusion of all market participants.

3.3 Sample of the Study

This consisted of the 20 listed firms that are actively traded and make up the NSE-20 share index. This is because shares reflect the underlying assets of a firm. Hence, the price of these equities reflect the value that the market places on these assets. Equity prices are affected by overall market factors and the movement of the index may be taken as a proxy for expectations about the economy. Data that was analysed consisted of annual time series data for NSE-20 share index covering a period of 22 years from January 1990 to December 2011. This was to get accurate results and achieve comprehensive coverage.

3.4 Data Collection

Time series secondary data from published reports and figures were sourced from the Nairobi Securities Exchange (NSE), the Central Bank of Kenya (CBK) and the Kenya National Bureau of Statistics (KNBS).

3.5 Data Analysis

Data analysis is the process of bringing order, structure and meaning to a large mass of information and comprises of examining what has been collected and making inferences and deductions (Kombo and Tromp, 2006). Advanced econometric models with the aid of statistical software

(Eviews version 7.0) were used to analyse the collected data so as to get precise results in the analysis of the GARCH model in determining and/ or capturing the impact of selected macroeconomic variables on stock return volatility. Descriptive statistics, correlation test, the unit root Augmented Dickey-Fuller test introduced by Dickey and Fuller (1979) and EGARCH (Nelson, 1991) were applied.

3.6 Analytical Framework

The following expression was used to transform market indices to market returns.

$$R_t = \text{LogNSE}_t - \text{LogNSE}_{t-1} \quad \text{.....(a)}$$

Where, NSE_t denotes the prices of the NSE 20 share index, R_t denotes the returns of the NSE 20 share index. The stock returns were calculated from the NSE 20 share index due to the fact that the index is the standard in measuring stock exchange performance.

Tests for Normality, Jarque-Bera (JB) test statistic was used to determine whether the six selected macroeconomic variables and stock market returns follow the normal probability distribution. The test statistic measures the difference of the skewness and Kurtosis of the series with those from the normal distribution. It is given in the following form.

$$\text{JB} = n\left[\frac{S^2}{6} + \frac{(K-3)}{24}\right] \quad \text{.....(b)}$$

Where S is the skewness and K is the Kurtosis, stationarity tests were also used to know whether the series contains a unit root (not stationary) and/or does not contain a unit root (stationary).

The Augmented Dickey-Fuller test (ADF) which is the modified version of Dickey-Fuller (DF) test, used to test for unit roots in the study was of the form:

$$\Delta Y_t = B_o + \beta Y_{t-1} + \mu_1 Y_{t-1} + \mu_2 Y_{t-2} + \mu_3 Y_{t-3} + \mu_4 Y_{t-4} + \mu_5 Y_{t-5} + \mu_6 Y_{t-6} \ldots\ldots + \mu_x Y_{t-x} + \varepsilon_t \ldots\ldots 3.7.1$$

Where, Y_t denotes time series to be tested, B_o is the intercept term, β is the coefficient of interest in the unit root test, μ_1 is the parameter of the augmented lagged first difference of Y_t to denote the p^{th} order autoregressive process, and ε_t is the white noise error term.

The hypothesis to be tested in applying the unit root test was:
Null hypothesis (non stationary) $H_o : \rho = 0$
Alternative hypothesis (stationary) $H_1 : \rho \neq 0$

Acceptance of the null hypothesis implies that the time series data are non- stationary and/ or presence of a unit root. Acceptance of the alternative hypothesis implies existence of stationarity and/ or absence of a unit root in the time series data.

EGARCH model was useful in analyzing and capturing the effect and/ or impact of selected macroeconomic variables on volatility of security prices by quantifying volatility persistence (α) in the stock exchange, the volatility magnitude (β), leverage effect (λ). The EGARCH model employed took the following form:

$$R_t = \beta_0 + \beta_1 \Delta INF + \beta_2 \Delta EXR + \beta_3 \Delta INT + \beta_4 \Delta M3 + \beta_5 \Delta M3X + \beta_6 \Delta GMS + \varepsilon_t \ldots\ldots (c)$$

Where, (R_t), returns of the NSE 20 share index, inflation rate (INF), exchange rate (EXR), interest rate (INT), money supply (M3), broad money supply (M3X), and general money supply (GMS).

$$\text{Log}(\delta_t^2) = \omega + \beta \delta^2_{t-1} + \alpha \left| \frac{\varepsilon_{t-1}}{\sigma_{t-1}} \right| + \lambda \frac{\varepsilon_{t-1}}{\sigma_{t-1}} + \delta_t \ldots\ldots (d)$$

EGARCH model was useful in analyzing and capturing the effect and/ or

Where, Log (δ_t^2) denotes log of conditional variance of stock exchange returns, δ_t denotes exchange rate volatility, β is the vector of coefficient, λ is the leverage effect and ε_t is the error term. Leverage effect is shown by $\lambda < 0$. If $\lambda \neq 0$ then the impact of information based on a certain macroeconomic variable on stock return volatility is asymmetric.

To affirm and prove findings of EGARCH in explaining as well as capturing the effect of selected macroeconomic variables on volatility of security prices, TGARCH model which was introduced by Zakoian (1994) and Glosten, Jaganathan and Runkle (1993) was applied, and it takes the following form:

$$\sigma_t^2 = \omega + a\,\varepsilon_{t-1}^2 + \beta\,\sigma^2_{t-1} + \lambda\varepsilon_{t-1}^2 \Gamma_{t-1} \quad \text{.....(e)}$$

Where, positive information about a macroeconomic variable is, $\varepsilon_{t-1}^2 > 0$, and negative information $\varepsilon_{t-1}^2 < 0$, have differential effects on the conditional variance. α denotes the impact of positive information while $\alpha + \lambda$ denotes the impact of negative information. If $\lambda > 0$, indicates that negative information about a certain and/ or all selected macroeconomic variable increases volatility in the stock exchange, suggesting existence of leverage effect of the first order. Whereas if $\lambda \neq 0$, this shows that the information and/ or news impact of all and/or certain selected macroeconomic variable is asymmetric.

3.7 Expectations of the Study

Significant clustering in volatility during relative macroeconomic instability period than relative macroeconomic stability period is expected, hence a strong significant relationship between stock returns and conditional volatility (risk), which would imply that there is a significant relationship between time varying risk premium and stock returns. Therefore, whether the macroeconomic variables are stable or not the Nairobi Securities Exchange (NSE) will continuously price the stocks efficiently. Hence, investors trading at the Nairobi Securities Exchange (NSE) are mostly risk averse, whether macroeconomic climate is stable or not.

PART IV

DATA ANALYSIS AND INTERPRETATION

4.1 Introduction

4.1.1 Descriptive Statistics and Tests for Normality

In testing the effect of macroeconomic variables on volatility of securities prices, the findings in table 4.2.1 below, show that all the selected macroeconomic variables are not normally distributed, apart from exchange rate (EXR) whose kurtosis coefficient is close to 3 (3.104332) and skewness is close to zero (0.811810). All the variables except exchange rate (EXR) exhibit negative skewness, which implies that the left tail is particularly extreme. The values of computed kurtosis indicate positive kurtosis for the entire data set as this value is greater than 3. This means that the probability distribution functions (PDFs) for all the variables are leptokurtic that they exhibit slim or long tail. Lastly Table 4.2.1 indicates the Jarque Bera normality test statistic results which confirm non normality at 1% level using the p-values. Note: The NSE 20 share index was first transformed to stock market returns using model (a) discussed in Section 3.7. Statistically, this study employed the Jarque-Bera test to test for normality in the time series data that were used. The Jarque-Bera (JB) test statistic was used to determine whether the selected macroeconomic variables and stock returns follow the normal probability distribution. The Jarque-Bera (JB) statistics was used to find out the normality of the returns series under investigation. This test measured the difference of the Kurtosis and skewness of the sock return series with those from normal distributions.

Table 4.2.1: *Descriptive Statistics of Selected Macroeconomic Variables*

Sample: 1990-2011	*Selected Macroeconomic Variables*						
	RETURNS	**INF**	**EXR**	**INT**	**M3**	**M3X**	**GMS**
Mean	1.788594	0.985880	0.054933	1.019413	4.553020	4.125101	4.960460
Median	1.850439	1.025132	0.045817	1.039789	5.043321	4.194410	5.503488
Maximum	1.929766	1.662758	0.449517	1.594834	6.065925	5.384735	6.180169
Minimum	1.381729	0.204120	−0.174342	0.149219	2.857574	2.684989	3.462667
Std. Dev.	0.149947	0.355838	0.164172	0.319858	1.183060	0.901262	0.973523
Skewness	−1.587159	−0.458909	0.811810	−1.006681	−0.367768	−0.136587	−0.190579
Kurtosis	4.462940	3.077632	3.104332	4.346972	1.467148	1.543736	1.299737
Jarque-Bera	11.19845	0.777715	2.426442	5.378961	2.649762	2.012384	2.783162
Probability	0.003701	0.677831	0.297238	0.067916	0.265835	0.365609	0.248682
Sum	39.34908	21.68935	1.208517	22.42708	100.1664	90.75222	109.1301
Sum Sq. Dev.	0.472169	2.659028	0.566002	2.148487	29.39224	17.05775	19.90271
Observations	22	22	22	22	22	22	22

Source: *Survey Data (2012)*

Where, N =sample size, S = skewness of coefficient, and K kurtosis coefficient. For a normally distributed variable, S 0 and K 3, hence, the Jarque-Bera (JB) test of normality is a test of the joint hypothesis that S and K are 0 and 3.

4.2 Stationarity Test

In data analysis it is important to know whether a series contains a unit root (not stationary) or do not contain a unit root (stationary). This is imperative since both the right and left side variables of our regression model need to balance.

Whereas, time series data are often assumed to be non-stationary, it is important that a pretest be performed to ensure that there is a stationary relationship between volatility of stock returns and the six selected macroeconomic variables (inflation rate, foreign exchange rate, interest rate, money supply, broad money supply and the general money supply), so as to avoid the problem of spurious regression when the time series data is analysed (Riman and Eyo, 2008).

According to Patterson (2000), spurious regression is cited to exist when the test statistics show a significant relationship between variables in the regression model even though there is no existence of such relationship between them. Therefore, quantitative analysis was applied to take into account the issue of non-stationarity and hence avoid the problem of spurious regression.

The Augmented Dickey-Fuller test (ADF) was used to test for unit roots. Modified version of Dickey-Fuller (DF) test, that is Augmented Dickey-Fuller (ADF) test was carried out, since it makes a parametric correction in the original Dickey-Fuller (DF) test for higher-order correlation, by assuming that the series follows an AR (p) process. The Augmented Dickey-Fuller test specification used here is shown in section 3.7.1.The hypothesis applied in testing the unit root test was:

Null hypothesis (non stationary) of $H_o : \rho = 0$

Alternative hypothesis (stationary) of $H_1 : \rho \neq 0$

The decision criteria involved comparing the computed Tau values with the MacKinnon critical values for the rejection of the hypothesis for a unit root. If the computed tau, Augmented Dickey-Fuller (ADF) statistic is more negative, in that it lies to the left of the MacKinnon critical values relative to the critical values, the alternative hypothesis of stationarity will be accepted, hence rejection of the null hypothesis of non-stationarity in the time series variables.

4.3.1 Findings of Augmented Dickey-Fuller (ADF) Stationarity Test

In testing the effect of macroeconomic variables on volatility of security prices, Augmented Dickey-Fuller test (ADF) test at level (Trend and Intercept), was applied whereby, only stock returns and interest rate (INT) are stationary. Since they are more negative and/ or they lay to the left of the critical value, thus support the alternative hypothesis of stationarity or absence of a unit root in the series of stock returns and interest rates.

Therefore, by testing the effect of macroeconomic variables on volatility of security prices; general money supply (GMS), money supply (M3), broad money supply (M3X), inflation rate (INF), and exchange rate (EXR) were the only non-stationary independent macroeconomic variables.

Table 4.2.2: *Augmented Dickey-Fuller (ADF) Stationarity Test*

	ADF Test at Level (Trend and Intercept)				
Variable	*ADF Statistic*	*Critical Value*	*DW*	*Lag*	*Inference*
EXR	−3.118492	−3.644963	2.625511	0	I(1)
GMS	−2.126996	−3.644963	1.865944	0	I(1)
INF	−3.461124	−3.644963	1.874980	0	I(1)
INT	−4.285208	−3.644963	1.820585	0	I(0)
M3	−1.927700	−3.644963	2.026323	0	I(1)
M3X	−3.356252	−3.644963	1.890391	0	I(1)
RETURNS	−4.056561	−3.644963	2.009301	0	I(0)

**MacKinnon critical values for rejection of hypothesis of a unit root at 5%.*
Source: *Survey Data (2012)*

This can be proved by the fact that they are less negative and/ or lay to the right of the critical values. Hence, they satisfy our null hypothesis of non-stationarity or presence of a unit root in all the residual selected macroeconomic variables for exchange rate (EXR), general money supply (GMS), inflation rate (INF), money supply (M3) and broad money supply (M3X). As a result of the presence of a unit root in the remaining five selected macroeconomic variables (exchange rate (EXR), general money supply (GMS), inflation rate (INF), money supply (M3) and broad money supply (M3X)), Augmented Dickey-Fuller test (ADF) was performed in the first difference with MacKinnon critical values for the rejection of the hypothesis of a unit root at 5%, to the remaining five selected macroeconomic variables, which did not satisfy our alternative hypothesis of stationarity and/ or absence of a unit root.

4.3.2 Findings of ADF Stationarity Test at 1st Difference

Further testing for the effect, macroeconomic variables have on volatility of securities prices, at the first difference, there is a deduction that exchange rate (EXR), general money supply (GMS), inflation rate (INF), money supply (M3) and broad money supply (M3X) are stationary since their critical values is greater than Augmented Dickey-Fuller (ADF) statistic.

Table 4.2.3: *Augmented Dickey-Fuller (ADF) Stationarity Test at 1st Difference*

ADF Test at Level (Trend and Intercept)					
Variable @ 1st diff	*ADF Statistic*	*Critical Value*	*DW*	*Lag*	*Inference*
EXR	−6.516905	−3.658446	2.009215	0	I(1)
GMS	−4.780091	−3.658446	2.032097	0	I(1)
INF	−5.434259	−3.658446	2.271394	0	I(1)
M3	−5.103665	−3.658446	2.129317	0	I(1)
M3X	−5.488126	−3.658446	2.114442	0	I(1)

**MacKinnon critical values for rejection of hypothesis of a unit root at 5%.*
Source: *Survey Data (2012)*

Thus Augmented Dickey-Fuller (ADF) statistic is more negative than the critical value. Therefore we accept the alternative hypothesis since the remaining five macroeconomic variables (exchange rate (EXR), general money supply (GMS), inflation rate (INF), money supply (M3) and broad money supply (M3X)) have no unit root at the 1st difference.

4.4 Correlation Matrix Test

4.4.1 Findings of Correlation Matrix Test

In testing the effect of macroeconomic variables on volatility of security prices, a test for correlation between the variables shows positive and negative correlation. Some of the selected macroeconomic variables indicated weak positive and negative correlation between them. For

instance, when foreign exchange rate (EXR) increases by 1%, stock return decreases by 58.52%.

Table 4.2.4: *Correlation Matrix Test*

	EXR	*GMS*	*INF*	*INT*	*M3*	*M3X*	*RETURNS*
EXR	1.000000	−0.362335	0.458218	−0.062564	−0.421393	−0.354406	−0.585207
GMS	−0.362335	1.000000	−0.202892	−0.658182	0.941793	0.942465	0.765285
INF	0.458218	−0.202892	1.000000	0.295830	−0.364912	−0.224876	−0.318926
INT	−0.062564	−0.658182	0.295830	1.000000	−0.687764	−0.664243	−0.395518
M3	−0.421393	0.941793	−0.364912	−0.687764	1.000000	0.959811	0.772491
M3X	−0.354406	0.942465	−0.224876	−0.664243	0.959811	1.000000	0.752729
RETURNS	−0.585207	0.765285	−0.318926	−0.395518	0.772491	0.752729	1.000000

Source: *Survey Data (2012)*

This implies that when exchange rate (EXR) increases, investors become pessimistic in their expectations, hence shy away from the stock exchange by selling off their equity thereby depreciating equity return. When interest rate appreciates by 1%, stock returns plummets' by 39.55%. This might be prompted by investors selling off their equity to invest in risk free T-Bills. The test also shows that when inflation rate appreciates by 1%, equity return depreciates by 31.89%. Increase in price levels is as a result of inflation, over a certain time, hence influencing investors to lose confidence in the stock exchange.

Similar results are obtained when general money supply (GMS) appreciates by 1%, whereby equity returns appreciates by 76.52%, whereas when money supply (M3) accelerates by 1%, equity returns appreciates by 77.25%. Moreover, when broad money supply (M3X) increases by 1% stock returns increases by 75.27%. From the test in table 4.2.4, foreign exchange rate (EXR) fluctuations affect equity return volatility more than interest rate (INT), and inflation rate (INF), except general money supply (GMS), broad money supply (M3X) and money supply (M3). There is also a deduction that interest rate (INT) and inflation rate (INF) fluctuation have a marginal impact on security prices. These findings are in unision with the results by Olweny and Omondi (2011),

who found out that foreign exchange rate (EXR) affected stock return volatility more than interest rate and inflation rate whereas interest rate had a slight impact on equity return volatility.

4.5 Cross Correlation Test

4.5.1 Findings of Cross Correlation Test

Findings in Table 4.2.5, a test for cross correlation between the variables, to test for the effect of macroeconomic variables on volatility of securities prices, shows that at least 55% of the t-values of money supply (M3), and broad money supply (M3X) are greater than +2, implying that the coefficient were able to be estimated with fair amount of accuracy. Thus the coefficients are at least twice as large as the standard error. Hence, concluding that the two macroeconomic variables, that is money supply (M3) and broad money supply (M3X) have a significant impact on the dependent variable of stock returns, thus the greater the confidence in the coefficient as a predictor.

Table 4.2.5: *Cross Correlation Test*

Vector Autoregressive Estimates			*Date:04/10/13 Time:14:10*		*Included observations: 20 after adjustments*		
Standard errors in () & t-statistics in H H			*Sample (adjusted) observations: 1992-2011*				
	EXR	***GMS***	***INF***	***INT***	***M3***	***M3X***	***RETURNS***
EXR (−1)	1.219999	6.521816	13.05936	20.62119	−70.16480	−38.19844	−0.630122
	(2.0E−11)	(7.19059)	(18.0991)	(18.9029)	(10.9600)	(3.34195)	(6.47191)
	[6.2e+10]	[0.90699]	[0.72155]	[1.09090]	[−6.40192]	[−11.4300]	[−0.09736]
EXR (−2)	−0.350013	−2.741733	−3.288898	−6.062628	21.84066	12.54496	0.134340
	(5.9E−12)	(2.13353)	(5.37023)	(5.60872)	(3.25195)	(0.99160)	(1.92029)
	[−6.0e+10]	[−1.28507]	[−0.61243]	[−1.08093]	[6.71617]	[12.6513]	[0.06996]
GMS (−1)	−1.76E−13	0.033454	0.058964	−0.074250	0.389059	−0.264749	0.010576
	(3.4E−13)	(0.12407)	(0.31228)	(0.32615)	(0.18910)	(0.05766)	(0.11167)
	[−0.51472]	[0.26964]	[0.18881]	[−0.22765]	[2.05739]	[−4.59138]	[0.09471]

Vector Autoregressive Estimates			*Date:04/10/13 Time:14:10*		*Included observations: 20 after adjustments*		
Standard errors in ( ) & t-statistics in H H			*Sample (adjusted) observations: 1992-2011*				
	EXR	***GMS***	***INF***	***INT***	***M3***	***M3X***	***RETURNS***
	1.80E−13	−0.127846	0.150463	−0.127730	−0.815857	0.141548	−0.061651
GMS	(3.1E−13)	(0.11208)	(0.28211)	(0.29464)	(0.17083)	(0.05209)	(0.10088)
(−2)	[0.58264]	[−1.14067]	[0.53334]	[−0.43351]	[−4.77573]	[2.71730]	[−0.61115]
	6.99E−13	−0.129998	0.073138	0.377020	−0.705382	−0.157056	−0.026990
INF	(4.4E−13)	(0.15832)	(0.39850)	(0.41620)	(0.24131)	(0.07358)	(0.14250)
(−1)	[1.60559]	[−0.82110]	[0.18353]	[0.90586]	[−2.92309]	[−2.13442]	[−0.18941]
	−7.88E−14	0.033981	−0.229951	−0.134641	0.621153	0.424029	−0.027670
INF	(3.3E−13)	(0.11998)	(0.30199)	(0.31540)	(0.18287)	(0.05576)	(0.10799)
(−2)	[−0.23871]	[0.28323]	[−0.76146]	[−0.42689]	[3.39670]	[7.60436]	[−0.25624]
	5.04E−13	0.219361	−0.038221	−0.223269	−1.130961	−0.602848	−0.018268
INT	(4.4E−13)	(0.16096)	(0.40514)	(0.42314)	(0.24534)	(0.07481)	(0.14487)
(−1)	[1.13953]	[1.36284]	[−0.09434]	[−0.52765]	[−4.60985]	[−8.05854]	[−0.12610]
	5.92E−13	0.211568	−0.098836	−0.089606	−0.370599	0.124231	0.008665
INT	(4.8E−13)	(0.17578)	(0.44245)	(0.46209)	(0.26792)	0.08170)	(0.15821)
(−2)	[1.22342]	[1.20361]	[−0.22338]	[−0.19391]	[−1.38323]	[1.52065]	[0.05477]
	5.02E−13	0.216981	−0.337622	0.319445	−0.045047	0.036416	0.052025
M3	(3.8E−13)	(0.13970)	(0.35162)	(0.36724)	(0.21293)	(0.06493)	(0.12573)
(−1)	[1.30665]	[1.55323]	[−0.96018]	[0.86985]	[−0.21156]	[0.56088]	[0.41377]
	1.76E−13	0.621117	0.299957	−0.535941	0.170689	0.057917	−0.033759
M3	(3.2E−13)	(0.11628)	(0.29268)	(0.30568)	(0.17723)	(0.05404)	(0.10466)
(−2)	[0.55140]	[5.34166]	[1.02487]	[−1.75330]	[0.96308]	[1.07170]	[−0.32257]
	5.51E−13	−0.132280	0.695781	0.206662	−1.338462	−0.373319	0.022691
M3X	(5.2E−13)	(0.19026)	(0.47890)	(0.50017)	(0.29000)	(0.08843)	(0.17125)
(−1)	[1.05253]	[−0.69525]	[1.45286]	[0.41318]	[−4.61536]	[−4.22172]	[0.13250]
	4.43E−13	0.600191	−0.146928	0.830341	−0.596264	−0.331993	0.024579
M3X	(4.4E−13)	(0.16006)	(0.40287)	(0.42076)	(0.24396)	(0.07439)	(0.14406)
(−2)	1.00618]	[3.74986]	[−0.36470]	[1.97341]	[−2.44410]	[−4.46291]	[0.17062]
	0.780001	−0.130972	0.837989	−0.545072	1.165810	1.128584	0.090112
RETURNS	(1.2E−12)	(0.44728)	(1.12584)	(1.17584)	(0.68175)	(0.20788)	(0.40258)
(−1)	[6.3e+11]	[−0.29282]	[0.74432]	[−0.46356]	[1.71001]	[5.42894]	[0.22384]
	−0.649988	−4.618995	−14.06399	−16.35076	56.01361	28.68067	0.720477
RETURNS	(1.6E−11)	(5.73700)	(14.4404)	(15.0817)	(8.74439)	(2.66637)	(5.16360)
(−2)	[−4.1e+10]	[−0.80512]	[−0.97394]	[−1.08415]	[6.40567]	[10.7564]	[0.13953]
	−3.08E−12	1.136825	3.811075	2.220973	2.434061	1.489285	1.316161
	(2.4E−12)	(0.87866)	(2.21163)	(2.30985)	(1.33926)	(0.40837)	(0.79084)
C	[−1.27426]	[1.29382]	[1.72320]	[0.96152]	1.81747]	[3.64689]	[1.66426]

Vector Autoregressive Estimates			*Date:04/10/13 Time:14:10*		*Included observations: 20 after adjustments*		
Standard errors in () & t-statistics in H H			*Sample (adjusted) observations: 1992-2011*				
	EXR	***GMS***	***INF***	***INT***	***M3***	***M3X***	***RETURNS***
R-Squared	1.000000	0.996509	0.866874	0.821201	0.994720	0.999113	0.734284
Adj.R-Squared	1.000000	0.986736	0.494121	0.320563	0.979937	0.996628	−0.009721
Sum-Square residuals	4.04E −25	0.053439	0.338566	0.369305	0.124150	0.011543	0.043290
S.E. equation	2.84E −13	0.103382	0.260218	0.271774	0.157575	0.048048	0.093049
F-Statistic	2.13E +23	101.9576	2.325599	1.640308	67.28621	402.0805	0.986934
Log likelihood		30.87075	12.40892	11.53988	22.44123	46.19511	32.97678
Akaike AIC		−1.587075	0.259108	0.346012	−0.744123	−3.119511	−1.797678
Schwarz SC		−0.840276	1.005907	1.092811	0.002677	−2.372712	−1.050879
Mean Dependent	1.840364	5.104867	0.964836	1.000016	4.716460	4.260544	1.825952
S.D. Dependent	0.112664	0.897634	0.365859	0.329711	1.112468	0.827400	0.092600
Determinant resid covariance (dof adj.)		0.000000					
Determinant resid covariance		0.000000					

Source: *Survey Data (2012)*

Table 4.2.5 shows that findings of t-values of exchange rate (EXR), general money supply (GMS), inflation rate (INF), interest rates (INT) are less than +2. It implies implying that they have a slight impact on stock returns, hence indicating the low reliability of the predictability power of these coefficients. Since the standard error gives an idea about the reliability and precision of a sample. From the results in table 4.2.5, at least 80% of the standard error values of the macroeconomic variables are below one, indicating the greatness of the uniformity of the sampling distribution and hence reaffirming the greatness in the reliability of the sample. Therefore, at 5% level of significance, there is a 95% confidence that the answer will not fall outside the range and/ or the said difference is not due to fluctuations of sampling. Under the criteria of higher R^2 the greater the variation of Y (stock returns) explained by the regression plane, that is, the better the

'goodness of fit' of the regression plane to the sample observations, whereas the closer R^2 to zero, the worse the fit. From the analysis of the findings in table 4.2.5, the coefficient of multiple determination and/ or the squared multiple correlation coefficient for all the macroeconomic variables is greater than 70%. This implies that at least 70% of the total variation and/ or variance in stock returns are explained by the regression plane, that is, by changes in the explanatory macroeconomic variables (exchange rate (EXR), money supply (M3), inflation rate (INF), interest rate (INTR), money supply (M3) and broad money supply (M3X)). Whereas 30% of the total variance, are explained by other variables that are not included in the model. The observations show an almost perfect 'goodness of fit' with a majority of squared multiple correlation coefficients of 80% as indicated in table 4.2.5.

4.6 EGARCH Model Test

4.6.1 EGARCH Model Test Findings

Further testing the effect of foreign exchange rate (EXR) on volatility of securities prices as shown in table 4.2.6 indicates that the magnitude of volatility, as denoted by β is relatively low at 0.107477 and insignificant at 0.9838.

Table 4.2.6: *EGARCH Model Test on the Effect of Exchange rate (EXR) on Stock Return Volatility*

	Variance Equation	
	Coefficient	*Probability*
ω	−0.243068	0.9775
β	0.107477	0.9838
α	−0.471815	0.9109
λ	−0.128517	0.9527

Source: *Survey Data (2012)*

This may be attributed to investors opting for investments dealing in less risky domestic currency as compared to investments in more risky foreign currency. Volatility persistence of exchange rate (EXR) was found to be low at −0.471815 but insignificant with a probability of 0.9109. The direction of effect being ë < 1 at 0.128517 is insignificant at the conventional levels of testing as indicated by a probability value of 0.9527. Moreover, the negative sign of 0.128517 denotes that there are leverage effects in the equity returns series and that negative information about foreign exchange rate (EXR) has a larger impact on volatility of security prices. Being insignificant implies that these effects are not pronounced during the sampled periods. The findings show that negative information about foreign exchange rate (EXR), impact more on stock return volatility than positive information in the market.

In testing the effect of interest rate (INT) volatility on security prices, from table 4.2.7, volatility magnitude is low and insignificant as measured by β, is at 0.335983 with a probability of 0.9511. The measure of volatility persistence denoted by α, is at 0.021904, and it is insignificant since it has a probability of 0.9952.

Table 4.2.7: *EGARCH Model Test on the Effect of Interest rate (INT) on Stock Return Volatility*

	Variance Equation	
	Coefficient	*Probability*
ω	−0.277926	0.9772
β	0.335983	0.9511
α	−0.021904	0.9952
λ	−0.268382	0.8845

Source: *Survey Data (2012)*

ë < 1, being at −0.268382 is also insignificant with a probability of 0.8845 denoting, the presence of a weak leverage effect. The negative sign of 0.268382 implies existence of leverage effects in equity returns series and that negative news about interest rate (INT) has a larger impact on volatility of security prices. Being insignificant implies that, leverage effects are not pronounced during the sampled periods. These findings are inconsistent with those of Rajni & Mahendra (2007) and Olweny & Omondi (2011), who found that interest rate (INT), has a significant impact on equity return volatility, whereas their leverage effect was significant implying that they were more pronounced during their sampled period.

Testing for the effect of inflation rate (INF) on volatility of security prices; results in table 4.2.8 show that volatility magnitude (β) is low at 0.239390 and insignificant, since it has a probability of 0.9696. This may be as a result of the notion that inflation rate (INF) has a relatively smaller impact on investment at the bourse. Volatility persistence as measured by α is also low at 0.245460 and insignificant with a probability of 0.9638 which is close to one.

Table 4.2.8: *EGARCH Model Test on the Effect of Inflation rate (INF) on Stock Return Volatility*

	Variance Equation	
	Coefficient	*Probability*
ω	−0.272954	0.9773
β	0.239390	0.9696
α	−0.245460	0.9638
λ	−0.021256	0.9874

Source: *Survey Data (2012)*

The presence of leverage effect can be proved by ë < 1. The results show its existence by −0.021256 with a probability of 0.9874, depicting that leverage effect is insignificant. This implies that negative information about inflation rate (INF) has a larger impact on equity return volatility than positive information. Being insignificant implies that, leverage effects are not pronounced during the sampled periods.

In carrying out a test of the effect of general money (GMS) on volatility of security prices, the findings in table 4.2.9 reveal that volatility magnitude is low at 0.280337 and insignificant at 0.9398. Volatility persistence as measured by α is also low at 0.802839 and insignificant with a probability of 0.8743 which is close to one. Whereas, its leverage effect (ë) is 0.074132 and insignificant at 0.9551. The presence of leverage effect can be proved by ë < 1. General money supply (GMS) has a very low leverage effect, since its leverage effect (ë) is less than 1. This is evidence that negative information about general money supply (GMS) has a larger impact on stock return volatility than positive information.

Table 4.2.9: *EGARCH Model Test on the Effect of General Money Supply (GMS) on Stock Return Volatility*

	Variance Equation	
	Coefficient	*Probability*
ω	−0.278765	0.9797
β	−0.280337	0.9398
α	−0.802839	0.8743
λ	0.074132	0.9551

Source: *Survey Data (2012)*

Testing the effect of money supply (M3) on volatility of security prices, from the results in table 4.2.10 shows that the magnitude of volatility, as denoted by β is relatively low at 0.348479 and insignificant with a probability of 0.9431.The high estimated β, denotes that the magnitude of shocks has an insignificant impact on volatility of security prices.

Table 4.2.10: *EGARCH Model Test on the Effect of Money Supply (M3) on Stock Return Volatility*

	Variance Equation	
	Coefficient	*Probability*
ω	−0.607137	0.9158
β	0.348479	0.9431
α	0.126994	0.9798
λ	−0.007139	0.0000

Source: *Survey Data (2012)*

α as a measure of persistence of volatility during the period, is low at 0.126994 and insignificant with a probability of 0.9798. Whereas, ë < 1 is significant, proving the existence of leverage effect at the Nairobi Securities Exchange (NSE). The negative sign of –0.007139 suggests existence of leverage effect in the stock returns series, and that negative information has a significant impact on volatility of securities prices. The presence of leverage effects can be illustrated by ë < 1, with a probability of zero which means that it is significant. Leverage effect being significant implies that it is more pronounced during the sampled periods.

In testing the effect of broad money supply (M3X) on volatility of securities prices, findings in table 4.2.11 shows that the magnitude of volatility as measured by β, is low at −0.134503 and insignificant with a probability of 0.9717, which is almost close to one.

Table 4.2.11: *EGARCH Model Test on the Effect of Broad Money Supply (M3X) on Stock Return Volatility*

	Variance Equation	
	Coefficient	*Probability*
ω	−0.082126	0.9940
β	−0.134503	0.9717
α	−0.898418	0.8546
λ	0.101494	0.9304

Source: *Survey Data (2012)*

In table 4.2.11, the measure of volatility persistence of broad money supply (M3X) is at −0.898418 with a probability of 0.8546 which is almost close to 1, hence not significant. Presence of leverage effect (ë) is at 0.101494 and is insignificant with a probability of 0.9304. The presence of leverage effect can be proved by ë < 1, whereas broad money supply (M3X) has a very low leverage effect. This is evidence that negative information about broad money supply (M3X) has a larger impact on stock return volatility than positive information. These indicates that the magnitude of shocks emanating from broad money supply (M3X), has a larger impact on volatility of security prices, even though, the leverage effect is not pronounced during the sampled period.

In testing the aggregate effect of overall macroeconomic variables on the volatility of securities prices, the findings in table 4.2.12 shows that equity returns has a negative relationship with foreign exchange rate (EXR). This shows that when foreign exchange rate (EXR) appreciates, equity returns declines since investors sell off their equity to take advantage of foreign exchange rate (EXR) parity.

Table 4.2.12: *EGARCH Model Test on the Effect of Macroeconomic Variables on Stock Return Volatility*

	Variance Equation	
	Coefficient	*Probability*
INF	0.006814	0.7435
EXR	−0.323995	0.0000
INT	0.028675	0.7110
M3	0.015090	0.4196
M3X	0.034599	0.3379
GMS	0.057548	0.0000
C	1.287157	0.0000

Source: *Survey Data (2012)*

When foreign exchange rate (EXR) declines investors buy more equity in expectation and/or anticipation of future increase in equity prices thereby increasing equity returns. This relationship is significant as demonstrated by probability of zero. The results also show that the impact of general money supply (GMS) is significant since it has a probability of zero. The findings also show that Inflation rate (INF) has an inverse relationship with the equity returns. However, its effect is not significant with a probability of 0.7435 which is not close to zero. Whereas the effect of exchange rate (EXR) and general money supply (GMS) is significant with probabilities of zero. Interest rate (INT) also has an inverse relationship with equity returns. This could be attributed to the fact that when the 91 day T-Bills rate increases, it attracts more investors prompting them to sell off their equity and invest in T-Bills and vice versa. Interest rate (INT) has a probability of 0.7110 which is not significant, whereas money supply (M3) and broad money supply (M3X) also behave in similar manner, with probabilities of 0.4196 and 0.3379, which is not close to zero hence their effect is not significant.

Table 4.2.13: *EGARCH Model Test on the Effect of Macroeconomic Variables on Stock Return Volatility*

	Variance Equation	
	Coefficient	*Probability*
ω	−2.314990	0.0165
β	−1.366413	0.2316
α	−1.732342	0.0001
λ	0.416608	0.0015

Source: *Survey Data (2012)*

In testing the aggregate effect of overall macroeconomic variables on the volatility of securities prices, the findings in table 4.2.13, β is negative at −1.366413 and significant at 0.2316, at the conventional level of testing for all the macroeconomic variables. The low estimated parameter is an indication that the magnitude of shocks of aggregate macroeconomic variables has a significant impact on volatility of securities prices.

The estimated parameter, α of 1.732342, shows volatility persistence at the Nairobi Securities Exchange (NSE) is highly persistent and significant, at a probability of 0.0001 which is closer to zero. These findings are consistent with those of Misati and Nyamongo (2010), who found that persistence of volatility, is quite high but differs from the findings of Olwenya and Omondi (2011) who found persistence of volatility to be quite low, even though significant at the Nairobi Securities Exchange (NSE).

In terms of the decay process of volatility, it is found that the effect of shock in returns is significant, but takes a short duration to lose its effect on the variance of returns. The direction of effect ë < 1 is significant at the conventional levels of testing.

There is some leverage effects in the stock return series, hence by being significant, this implies that these effects are pronounced during the sampled periods, and that negative information has significant impact on stock return volatility than positive information about all the six selected macroeconomic variables (inflation rate (INF), foreign exchange rate (EXR), interest rate (INT), money supply (M3), broad money supply (M3X) and the general money supply (GMS)).

This is in line with the findings of Olweny and Omondi (2011) who found that leverage effect is significant; implying that the effects are pronounced during the sampled periods and that negative information about aggregate macroeconomic variables has a significant impact on equity return volatility than positive information about the same aggregate macroeconomic variables. Whereas Misati and Nyamongo (2010) findings revealed that leverage effect is not significant, implying that the effects are not pronounced during the sampled periods.

In conclusion the effect and/ or impact of volatility persistence, volatility magnitude and leverage effect, that contribute holistically in capturing the overall effect macroeconomic variables have on volatility of securities prices is strongly and/ or significantly felt on volatility of securities prices, when the selected macroeconomic variables (inflation rate (INF), foreign exchange rate (EXR), interest rate (INT), money supply (M3), broad money supply (M3X) and the general money supply (GMS)) are jointly analysed and tested empirically by use of EGARCH model, than when the same selected macroeconomic variables are singularly analysed using the same model.

4.7 TGARCH Model Test

4.7.1 TGARCH Model Test Findings

In testing the aggregate effect of overall macroeconomic variables on volatility of securities prices in comparison to the findings of EGARCH

model test, TGARCH model test was carried out. Table 4.2.14 shows that news impact is asymmetric since ë ‘‘ 0. The findings are similar with those of the EGARCH model test where ë ‘‘ 0, at 0.998679.

Table 4.2.14: *TGARCH Model Test on the Effect of Macroeconomic Variables on Stock Return Volatility*

	Variance Equation	
	Coefficient	*Probability*
ω	0.000230	0.1734
β	−0.205734	0.1284
α	0.031081	0.8428
λ	0.998679	0.0000

Source: Survey Data (2012)

This is an indication that negative information increases volatility in the stock exchange, suggesting existence of a significant leverage effect, which is in unison with the findings of Misati and Nyamongo (2010) as well as the findings of Olwenya and Omondi (2011).The probability for the TGARCH test shows that, leverage effect is significant since the probability is zero. The results are also in unison with the findings of Olweny and Omondi (2011) but contradict those of Misati and Nyamongo (2010) who found leverage effect to be insignificant at the Nairobi Securities Exchange (NSE). Moreover, the magnitude of volatility (5) is low, but the aggregate magnitude of the shocks has a significant impact on volatility of securities prices; same findings as EGARCH findings.

PART V

CONCLUSIONS AND RECOMMENDATIONS

5.1 Summary of Findings

The study was conducted with the main aim of achieving the objective of establishing the effect and/ or the impact of macroeconomic variables on the volatility of security prices in Nairobi Securities Exchange (NSE).

The findings reveal existence of more significant relationship in some selected macroeconomic variables than others. For instance, in testing for the existence of correlation between stock returns as a dependent variable against each of the selected macroeconomic variables as explanatory variables, the findings reveal that the change in foreign exchange rate (EXR) has a significant impact on equity return, in that when foreign exchange rate (EXR) appreciates by 1%, equity returns depreciates by 58.52%.

Whereas a change in interest rate (INT) has a marginal impact on equity returns in that when interest rate (INT) changes by 1%, equity returns decreases by 39.55%. This reinforces the main objective by proving that volatility of equity returns is as a result of fluctuation in the macroeconomic variables, hence the need by the monetary authority to set policies that would stabilize macroeconomic variables, since volatility of the equity returns is a disincentive to investors. Moreover, a change in inflation rate (INF) by 1% results in decreasing equity returns by 31.89%. Other variables that were found to have had a significant impact of at least +75%, on equity returns when they change by 1%, were general money supply (GMS), money supply (M3) and broad money supply (M3X).

In empirical analysis, EGARCH and TGARCH model were employed in testing the effect of macroeconomic variables (inflation rate (INF), foreign

exchange rate (EXR), interest rate (INT), money supply (M3), broad money supply (M3X) and the general money supply (GMS)) on the volatility of security prices, in Nairobi Security Exchange (NSE). The study scope was further narrowed down to test, the leverage effect, volatility magnitude effect and volatility persistence of the six selected macroeconomic variables on the volatility of security prices.

According to the findings, the effect of exchange rate (EXR) fluctuations on volatility of securities prices in Nairobi Securities Exchange (NSE) is not significant. This is proven by the fact that, despite the presence of volatility persistence (5) of −0.471815, it is not significant as it has a probability of 0.9109 which is not close to zero. Whereas there is existence of leverage effect (ë) of 0.128517, it is insignificant, since it has a probability of 0.9527, which is not close to zero, implying that negative information about exchange rate (EXR) has a larger impact on volatility of security prices. Whereas being insignificant, leverage effect is not pronounced during the sampled period. Moreover, foreign exchange rate (EXR) magnitude of volatility (β) is relatively low at 0.107477 and insignificant at 0.9838. This findings are in line with the hypothesis that exchange rate (EXR) fluctuations has no significant effect on volatility of securities prices, despite the presence of leverage effect, volatility persistence and a certain magnitude of volatility shocks, which are not significant, since their effects are not pronounced during the sampled period.

The effect of interest rate (INT) fluctuations on volatility of securities prices in Nairobi Securities Exchange (NSE) is also not significant. This is proven by the fact that, despite the presence of volatility persistence (5) of 0.021904, it is not significant since it has a probability of 0.9952 which is not close to zero. There is existence of leverage effect (ë) of 0. 268382, which is also insignificant, since it has a probability of 0.8845, which is not close to zero, implying that negative information about interest rate (INT), has insignificant impact on volatility of security prices. Therefore, leverage

effect is not pronounced during the sampled period. Moreover, magnitude of volatility (β) is relatively low at 0.335983 and insignificant at 0.9511. These results are in line with the hypothesis that interest rate (INT) fluctuations has no significant effect on volatility of securities prices, despite the presence of leverage effect, volatility persistence and a certain magnitude of volatility shocks, which are not significant, since their effects are not pronounced during the sampled period.

According to the findings, the effect of inflation rate (INF) fluctuations on volatility of securities prices in Nairobi Securities Exchange (NSE) is not significant. This is proven by the fact that, despite the presence of volatility persistence (5) of 0.245460, it is not significant as it has a probability of 0.9638 which is not close to zero. Whereas there is existence of leverage effect (ë) of 0.021256, it is insignificant, since it has a probability of 0.9874, which is also not close to zero, implying that negative information, about inflation rate (INF) has a larger impact on volatility of security prices, even though, leverage effect is not pronounced during the sampled period. Moreover, magnitude of volatility (β) is relatively low at 0.239390 and insignificant at 0.9696. These findings are in line with the hypothesis that inflation rate (INF) fluctuations has no significant effect on volatility of securities prices, despite the presence of leverage effect, volatility persistence and a certain magnitude of volatility shocks which are not significant, since their effects are not pronounced during the sampled period.

The effect of general money supply (GMS) fluctuations on volatility of securities prices in Nairobi Securities Exchange (NSE) is not significant. This is proven by the fact that, despite the presence of volatility persistence (5Þ) of 0.802839, it is not significant as it has a probability of 0.8743 which is not close to zero. Whereas there is a very low presence of leverage effect, since ë is 0.074132, it is insignificant, since it has a probability of 0.9551, which is not close to zero. This implies that negative information, about general money supply (GMS) has a larger impact on volatility of

security prices, thus leverage effect is not pronounced during the sampled period. Moreover, magnitude of volatility (β) is relatively low at 0.280337 and insignificant at 0.9398. This findings are in line with the hypothesis that general money supply (GMS) fluctuations has no significant effect on volatility of securities prices, despite the presence of leverage effect, volatility persistence and a certain magnitude of volatility shocks which are not significant, since their effects are not pronounced during the sampled period.

The effect of money supply (M3) fluctuations on volatility of securities prices in Nairobi Securities Exchange (NSE) is significant. This is proven by the fact that, despite the presence of volatility persistence (5) of 0.126994, it is not significant as it has a probability of 0.9798 which is not close to zero. Whereas there is existence of leverage effect (ë) of 0.007139, it is significant, since it has a probability of 0.0000.This implies that, negative information about money supply (M3) has a significant impact on volatility of security prices than positive information, thereby the leverage effect is more pronounced during the sampled period. Moreover, magnitude of volatility (β) is relatively low at 0.348479 and insignificant at 0.9431. This findings also show that money supply (M3) fluctuations has a certain significant effect on volatility of securities prices due to presence of a significant leverage effect, despite volatility persistence and a certain magnitude of volatility shocks being insignificance.

The effect of broad money supply (M3X) fluctuations on volatility of securities prices in Nairobi Securities Exchange (NSE) is not significant. This is proven by the fact that, despite the presence of volatility persistence (5) of 0.898418, it is not significant as it has a probability of 0.8546 which is not close to zero. Presence of leverage effect can be proven by ë which is 0.101494, and is insignificant, since it has a probability of 0.9304, which is not close to zero. This implies that negative information, about broad money supply (M3X) has a larger impact on volatility of security prices. Hence, leverage effect is not pronounced during the sampled period.

Moreover, magnitude of volatility (β) is relatively low at 0.134503 and insignificant at 0.9717. This findings are in line with the hypothesis that broad money supply (M3X) fluctuations has no significant effect on volatility of securities prices despite the presence of leverage effect, volatility persistence and a certain magnitude of volatility shocks, since their effects are not pronounced during the sampled period.

Employing mean equation to analyse the overall effect of all the selected macroeconomic variables (inflation rate (INF), foreign exchange rate (EXR), interest rate (INT), money supply (M3), broad money supply (M3X) and the general money supply (GMS)) on volatility of security prices, the effect of foreign exchange rate (EXR) and general money supply (GMS) are significant with probabilities of zero. Whereas the effect of inflation rate (INF), interest rate (INT), money supply (M3), and broad money supply (M3X) are insignificant with probabilities of 0.7435, 0.7110, 0.4196 and 0.3379, which are not close to zero. These findings prove, as well as disapprove our hypothesis, since foreign exchange rate (EXR) and general money supply (GMS) fluctuations have significant effect, whereas inflation rate (INF), interest rate (INT), money supply (M3), and broad money supply (M3X) fluctuations, have no significant effect on volatility of securities prices.

Whereas by employing variance equation to analyse the overall effect of all the selected macroeconomic variables (inflation rate (INF), foreign exchange rate (EXR), interest rate (INT), money supply (M3), broad money supply (M3X) and the general money supply (GMS)) on volatility of security prices, their overall beta (β) is 1.366413, is significant at 0.2316 at a conventional level of testing for all the macroeconomic variables, indicating that the magnitude of shocks of aggregate macroeconomic variables has a significant impact on equity return volatility. Moreover, aggregate volatility persistence () for overall macroeconomic variables is 1.732342, and is highly persistent with probability of 0.0001 is also

significant. Last but not least, presence of overall leverage effect is significant with probability of 0.0015, which cements the presence of aggregate leverage effect. Being significant implies that these effects are more pronounced during the sampled periods and that negative information about all the macroeconomic variables has significant impact, on volatility of security prices than positive information. This findings show that aggregate macroeconomic variables fluctuations has significant effect on volatility of securities prices, due to significant overall leverage effect, aggregate volatility persistence and a certain magnitude of volatility shocks.

In proving and/ or reaffirming the findings of EGARCH test to be true, the TGARCH findings are similar to EGARCH results. This is shown by ë 0, at 0.998679, whereby, information impact is asymmetric since ë ‘“ 0, as shown in table 4.2.14.This proves earlier EGARCH findings that overall macroeconomic variables fluctuations has significant effect on volatility of securities prices, due to significant overall leverage effect, and a certain magnitude of volatility shocks, even though the aggregate volatility persistence is not significance due to its high probability of 0.8428, which is not close to zero, as obtained from TGARCH model.

In conclusion, these findings answer the main as well as specific objectives in establishing that, macroeconomic variables especially when amalgamated have an effect and/ or impact on the volatility of security prices in Nairobi Securities Exchange (NSE).

5.2 Conclusions

In testing their effect on volatility of securities prices; exchange rate (EXR), interest rate (INT), inflation rate (INF), general money supply (GMS), and broad money supply (M3X) fluctuations, there is a deduction of the existence of leverage effect, volatility magnitude effect and persistence of the volatility in the market, but their effect is not significant as denoted by their probability, which is not close to zero. Hence, exchange rate (EXR),

interest rate (INT), inflation rate (INF), general money supply (GMS), and broad money supply (M3X) fluctuations have no significant effect on volatility of securities prices, since their effect are not pronounced during the sampled period.

Whereas on money supply (M3) fluctuations, there is a deduction of existence of leverage effect, volatility magnitude effect and persistence of the volatility in the market, whereas leverage effect of money supply (M3) is significant, as denoted by its probability which is zero. Hence, money supply (M3) fluctuation has a significant effect on volatility of securities prices, since its effect is more pronounced during the sampled period.

Moreover, when all the macroeconomic variables are jointly tested under the EGARCH model there is a deduction that the overall magnitude of volatility (β), leverage effect (ë) and volatility persistence () is highly significant. The high significance implies, that these effect, especially the leverage effect, are more pronounced during the sample periods, and that negative information and/ or news about all the macroeconomic variables has significant effect and/ or impact on volatility of security prices than positive news. Moreover, overall magnitude of shocks emanating from all the macroeconomic variables aggregately has a significant effect on volatility of security prices. The EGARCH findings are subsequently supported by TGARCH findings, which similarly tested the effect of all the macroeconomic variables aggregately, on volatility of securities prices and thus deduction from TGARCH findings, is that the overall magnitude of volatility (β), and leverage effects (ë) is highly significant except aggregate volatility persistence () which is quite low and insignificance. These findings answer the main objective by establishing that, indeed, macroeconomic variables do have an effect and/ or impact on the volatility of security prices in Nairobi Securities Exchange (NSE).

From the findings, the six selected macroeconomic variables, affect the volatility of security prices of the NSE 20 share index. The main results

being that equity returns are asymmetric with leptokurtic features hence not normally distributed.

Misati and Nyamongo (2010) found out in their study that stock returns are symmetric but leptokurtic hence not normally distributed; volatility of returns is highly persistent; the leverage effect is not significant and the impact of news on volatility is not significantly asymmetric. Olwenya and Omondi (2011) findings revealed that equity returns are symmetric but leptokurtic hence not normally distributed; volatility of returns is not highly persistent but significant whereas the leverage effect is significant.

Stock exchange volatility is an imperative aspect in investor's decisions and expectations; therefore the part played by the stock market in an economy is of considerable importance and cannot be neglected. TGARCH findings reveal that information about the selected macroeconomic variables whether positive or negative has an asymmetric impact and/ or effect on volatility of security prices.

The findings are in line with earlier expectations of significant clustering in volatility as shown by the existence of significant leverage effect, during periods of relative macroeconomic instability than relative macroeconomic stability periods, since there is evidence that negative news has a larger impact on volatility of securities prices than positive news, this is in line with the results of EGARCH test performed earlier.

These findings also indicate the presence of a strong significant relationship between equity returns and conditional volatility and/ or risk. It also implies that there is a significant relationship between time varying risk premium and equity returns provided that the macroeconomic climate is stable, the Nairobi Securities Exchange (NSE) will continuously price stocks efficiently. This should not be the case, as the stock exchange is obligated to value equity correctly, whether the macroeconomic climate is stable or not.

There are other microeconomic factors beyond the scope of this study

which affect the efficiency of the stock exchange, for instance, the institutional structure which affect the efficiency of the stock exchange in its operations hence affecting the valuation of equities and lastly, settlement of trade deals that are affected by erratic macroeconomic climate.

Since the Nairobi Securities Exchange (NSE) plays a significant role in fast tracking economic growth and development, by providing an environment that is perfect, conducive and friendly for investment for both local and foreign investors, there is need for the monetary authority to stabilise macroeconomic variables.

From the findings we are also able to observe, theory of rational expectations and theory of rational beliefs taking shape. This can be seen in terms of the impact of negative information and positive news relating to macroeconomic variables, which then influence investors' future expectations and/ or beliefs of a specific equity, hence encourage or discourage one to buy, sell or repurchase more and/ or less equity. Therefore, good and/ or bad information in relation to macroeconomic variables, affects investors confidence in terms of investment in a certain stock, which ultimately influence the valuation of stock, hence the price and subsequently stock returns, ultimately affecting stock demand.

5.3 Policy Recommendations

Having observed that the presence of a stable macroeconomic environment yields a positive and significant relationship between equity return and conditional volatility (risk) as advocated by CAPM models, the study recommends the monetary authority to come up with policies that will facilitate the maintenance of a reasonable level of stability in the macroeconomic variables, which will enhance investors confidence on the stock exchange, as demand for a higher risk premium will decline thereby lowering the cost of capital which will subsequently increase investment and overall growth of the economy, therefore a relatively stable

macroeconomic environment must be maintained so as to make equity attractive by lowering the volatility of security prices and/ or returns.

5.4 Limitations of the Study

The study used published secondary data prone to all limitations associated with it, since the data comes with someone else rationale and assumptions about what is important, this will constrain my own freedom in interpreting the findings because of the author's emphasis or selectivity.

The study was undertaken with a fixed duration in mind, thus the accuracy of the findings is wanting; this limits the study in comparison to a longer time horizon which would provide greater accuracy.

Limitation of accurately capturing the effect caused by rational beliefs and/ or expectations of the investors using statistical models, due to the fact that the models have not been scientifically and/ or accurately proven to primarily deal with this issue.

It is difficult to access and costly to locate and/ or collect published secondary data, especially relating to the NSE 20 share index, due to immerse bureaucracy and redtape witnessed in various private and public institutions.

Limitation of succumbing to peer pressure in terms of applying EGARCH and TGARCH models in our analysis even though there are other competent versions of GARCH models such as GQARCH, PGARCH, AGARCH, and CGARCH among others.

5.5 Recommendations for Further Research

The methodology adopted by this study is one that uses EGARCH models to capture the asymmetric nature of equity returns, since there are arguments that equity returns respond asymmetrically to shocks of the same magnitude. There is urgency to prove this fact by applying GARCH

models that impose symmetry on the conditional variance, in comparison with GARCH models that impose asymmetry on the conditional variance.

Future research may be conducted by increasing the number of macroeconomic variables, as well as studying the direct effect of measures placed by the Central Bank of Kenya (CBK) such as monetary and/ or fiscal policy.

Institutional structures that affect operational efficiency of the bourse as well as settlement of trade deals, and industrial production that are affected by erratic macroeconomic climate need to be examined closely.

Future research may be conducted by inclusion of NSE All share index, FTSE NSE 15 share index, FTSE NSE 25, as well as AIG East Africa 27 share index and comparing the magnitude of the effect across the board.

Moreover, future research may be conducted by dividing the data collected into sub-periods, that is period of relative stability and instability, hence analyse the sub-periods separately and jointly, thus compare the results.

References

Bollerslev, T., Chou, R., & Kroner, K. (1992). ARCH modeling in finance, *Journal of Econometrics*. April/May, 52, 559.

Chinzara, Z., & Aziakponi, M. (2009). Dynamic returns linkages and volatility transmission between South African and the world major stock markets, *Journal of Studies in Economics and Econometrics*, 33(3), 6994.

Choudhry, T. (1996). Stock market volatility and the crash of 1987: evidence from six Emerging markets, Journal of International money and Finance, 15(6), 969981.

Chow, C.G. (2012).Usefulness of adaptive and rational expectations in economics. Retrieved from CEPS working paper:http:www.princeton.edu/ceps/221chowp Pdf

Cooper, R.D. & Schindler, P.S. (2006). Business research methods.9th edition. New Delhi:Tata McGraw Hill.

Diebold, X.F., & Yilmaz, K. (2012). Macroeconomic volatility and stock market volatility, Worldwide. Retrieved from nber working papers series http://www.n ber working papers series: http;//www.nber.org/w14269/pdf

Engle, R., Liline, D., & Robins, R. (1987). Estimating time varying risk premia in the term structure: The ARCHLM model, *Econometrica*, 55, 391407.

Fama, E.F. (1981). Stock returns, real activity, inflation and money, *America Economi Reviews*, 71, 545565.

French, K.R., Schwert, G.W., & Staumbaugh, R.F. (1987). Expected stock returns and volatility, *Journal of Financial Economics*, 19, 329.

Gujarati, D. (1995). *Basic Econometrics*, 3rd edition, McGraw Hill Irwin.

Herfeld, C. (2012). The potential and limitations of rational choice theory, *Erasmus Journal of Philosophy & Economics*, 5 (1), 7386.

Jackson, O.M., & Peck, J. (2012). Asymmetric information in a competitive market game: Reexamining the Implications of rational expectations. Retrieved from http:128.178.162/eps/mic/papers/pdf

Kaul, G. (1987). Stock Returns and Inflation; The role of the money sector, *Journal of Financial Economics*, 18, 253276.

Kearney, C., & Daly, K. (1998). The causes of stock market volatility, *Applied Financial Economics*, 8, 597-605.

Kenya Bureau of statistics, (2012), Economic Survey 2012 Highlights.

Kenya Bureau of statistics, (2012), Statistical Abstract 2012 Highlights.

Kerem, K., Listra, E., & Rahu, K. (2012).Market efficiency and rational expectations. Retrieved from http://www.ideas.repec.org/p/ttu/wpaper/112.html

Kibuga, K. (2002). The Role of the Nairobi Stock Exchange in Kenya. Nairobi Stock Exchange Handbook, 67.

Kurz, M. (2012). Endogenous uncertainty: A unified view of market volatility. Retrieved from nber working papers: http://www.econpapersrepec.org/pdf

Kurz, M., & Motolese, M. (2001). Endogenous uncertainty market volatility, Economic Theory, Retrieved from http://www.stanford,edu/mordecai/pdf

Lee, K. (1999). Unexpected inflation, inflation uncertainty and stock returns, *Applied Financial Economics*, 9, 315328.

Leigh,T. (2012). Introductory notes on rational expectations. Retrieved from http://www. econ,iastate.edu/tesfatsi/reintro.pdf

Lewellen, J. & Shanken, J. (2012). Market efficiency, rational expectations and Estimation of risk. Retrieved from h http://ssb.rochestor.edu/fac/shanken/index.html

Melzer, H.A. (2012). Rational expectations, risk, uncertainty and market responses. Retrieved from http://www.repository.cmu.edu/tepper/pdf

Mugo, J.M. (2001). *Applicability of Financial Crisis Predictive Model to Bank failures in Kenya*. Unpublished MBA project, University of Nairobi.

Munga, D.N. (1974). *The NSE, its history, organization and role in the*

Kenyan economy. Unpublished MBA project, University of Nairobi.

Muth, F.J. (961). Rational expectations and the theory of price movements, *Econometrica*, *a Journal of Econometric Society*, 29(3), 122.

Nelson, D.B. (1991). Conditional heteroskedasticity in asset returns: *A new approach Econometrica*, 59(2), 347-370.

Ngugi, R.W., Murinde, V., & Green, J.C. (2003). How have emerging stock exchanges in Africa responded to market reforms, *Journal of African Business*, 4(2), 89127.

Nyamongo, M.E. & Misati, R. (2010).Modelling the time-varying volatility of equities Returns in Kenya, AfricanJournal of Economic and Management Studies, 1(2), 182197.

Omet, G., khasawneh, M., & Khasawneh, J. (2002). Efficiency tests and volatility effects: Evidence from the Jordanian stock market, Applied Economics Letters, 9, 817 821.

O'Toole, K. (2012). Stanford news release: news service. Retrieved from http://news.stan Ford.edu/pr/stockprices.html

Otuke, J.O. (2006). *The impact of central depository system on performance of the NSE.* Unpublished MBA project, University of Nairobi.

Pudha, E.O. (2010). *A survey on the factors that motivate local individual investors to invest in shares of companies quoted at the NSE*. Unpublished MBA project, University of Nairobi.

Reserve Bank of Zimbabwe, (2003), Annual Report.

Shields, K.K. (1997). Stock return volatility on emerging Eastern European markets, The Manchester School Supplement, 00252034, 118138.

Testfatsion, L. (2012). Rational expectations, the efficient hypothesis and the Santa Fe artificial stock market model. Retrieved from http:// www.econ.iasate.ed/pdf

Zakoian, J.M. (1994). Threshhold heteroscedastic models, *Journal of Economic Dynamics and Control*, 18(5), 931935.

APPENDIX

Appendix II: List of Selected Macro-economic Variables

Raw Data on Selected Macroeconomic Variables

YEAR	NSE 20 SHARE INDICES ANNUAL AVERAGE	INFLATION RATE (%)	FOREIGN EXCHANGE RATE US DOLLAR TO KSHS	INTEREST RATES (%)	MONEY SUPPLY (M3) KSH MILLION	BROAD MONEY SUPPLY (M3X) KSH MILLION	GENERAL MONEY SUPPLY (GMS) KSH MILLION
1990	653.504	12.6	24.084	15.93	780.5	484.16	2,901.80
1991	942.47	19.6	28.074	16.77	880.8	718.38	3,716.31
1992	1142.08	27.3	36.216	16.96	994.2	1,248.28	6,604.74
1993	1628.05	46	68.163	39.34	835.2	1,276.83	8,079.47
1994	3989.53	28.8	44.839	17.9	720.4	1,921.47	10,291.10
1995	3446.92	1.6	55.939	21.67	2,441.20	1,291.15	11,554.31
1996	3116.81	9	55.0211	21.53	2,558.80	1,939.74	13,391.41
1997	3364.94	11.2	62.6778	13.4	2,556.10	1,688.22	14,702.61
1998	2972.35	6.6	61.9056	11.07	49,520	11,007	15,187.50
1999	2637.09	3.5	72.9306	13.47	49,169	16,756	15,605.80
2000	2070.3	10	78.0361	10.85	46,677	14,610	314,686
2001	1624.82	5.8	78.6	10.85	246,525	8,485	322,923
2002	1162.7	2	77.0723	8.38	262,603	36,652	350,733
2003	2079.76	9.8	76.1389	1.41	268,059	46,388	451,172
2004	2826.79	11.6	77.3444	8.29	289,818	60,253	511,425
2005	3655.08	10.3	72.3667	8.14	262,730	46,345	557,770
2006	4597.1	10.9	69.3967	5.83	266,673	94,872	653,035
2007	5258.37	11.1	62.675	6.87	342,553	124,560	777,596
2008	4522.71	17.8	77.711	8.59	294,219	123,459	901,055
2009	3027.31	9.9	75.82	6.82	408,779	144,602	1,045,657
2010	4257.69	3.5	78.034	2.28	1,163,455	225,982	1,271,638
2011	3751.88	14.5	85.068	17.9	1,163,926	242,513	1,514,152