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Dynamic Response of Stock Prices to Changes in Foreign Exchange Rate

[1*]Kirimi Elijah Thuranira, [2]Dr. Samuel Muthoga & [3]Dr. James Njatha Maingi
[1]PhD Student, Kenyatta University
[2&3]Lecturers, Kenyatta University
***Email of the corresponding author: kirimielijahket@gmail.com**

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Abstract

In Kenya, there has been volatility in exchange rates that have been deemed to have an adverse effect on the share prices. The study examined the dynamic response of stock prices to changes in foreign exchange rate. The target population consisted of monthly observations of the Nairobi All Share Index and the nominal Kenya shillings per US dollar exchange rates from the year 2008 to 2015. Secondary data was collected from Central Bank and Nairobi Securities Exchange. The research employed a Vector Auto-Regression model. Ordinary Least Square was used to examine long run relationship between stock prices and exchange rate on equation. The Vector Auto-Regression model was estimated and optimal lag length was obtained by use of Akaike Information Criterion. Vector Moving Average of the Vector Auto-Regression model with the subsequent derivation of impulse response functions and the variance decomposition was used to analyze the dynamic impact of changes in the level exchange rates on the stock prices. The study found that a one standard deviation shock in exchange rates initially leads to a negative impact on stock prices for the first six years, followed by a positive effect in the subsequent four years. The study concludes that exchange rate fluctuations have a significant and prolonged impact on stock prices, with effects that can last for several years. The study recommends that investors and policymakers should adopt a long-term perspective when considering the impact of exchange rate fluctuations on stock prices, given the extended period over which these effects materialize. In addition, companies engaged in international trade should implement financial instruments such as forwards and options to hedge against exchange rate risks.

Keywords: *Dynamic response, stock prices, foreign exchange rate, Kenya*

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1.0 Background

The dynamic response of stock prices to changes in foreign exchange rates is a complex interplay that has attracted significant scholarly attention due to its implications on global financial markets (Aggarwal, 1981). Stock prices are sensitive to a myriad of factors, with foreign exchange rates being a crucial component, as they directly affect the profitability of companies engaged in international trade (Ajayi & Mougoue, 1996). A depreciation in the local currency can lead to higher revenues for exporters, which in turn can boost their stock prices (Issam & Murinde, 1997). Conversely, an appreciation can have the opposite effect, reducing the competitiveness of exports and negatively impacting stock prices (Ajayi, Friedman, & Mehdian, 1998). This relationship underscores the interconnectedness of currency and equity markets, highlighting the global nature of financial markets today (Pan, Fok, & Liu, 2000).

Companies that earn a significant portion of their revenue in foreign currencies may see their stock prices rise when the local currency weakens (Osei, 2006). Moreover, the impact of exchange rate fluctuations on stock prices can also be influenced by investor sentiment and macroeconomic indicators. This makes the relationship between these two variables complex and subject to change over time (Adam & Tweneboah, 2008). This dynamic interaction highlights the importance of considering a wide range of factors when analyzing the relationship between foreign exchange rates and stock prices, and underscores the need for investors to stay informed about global economic trends and currency movements (Bonga & Hoveni, 2011). Stock prices can be influenced by volatility of the market, the prevailing economic conditions, and reputation of the company. Other than demand and supply, other macroeconomic variables such as exchange rate, interest rates, Gross Domestic Product, current account, employment, inflation, and money supply determine the demand and supply of shares, thus influencing share prices (Kurihara, 2006).

Understanding the impact of exchange rate fluctuations on a firm's stock price is crucial to the implementation of successful trade policy. has been particularly turbulent since 2007, a period marked by post-election violence. The USD/Ksh spot exchange rate has depreciated by 0.20 percent over the last ten years (Obura et al., 2013). From 1993 to 2013, the USD/Ksh averaged 75.99, reaching an all-time high of 105.75 in October of 2011 and recorded a low of 36.23 in January of 1993 (KPMG, 2012). The USD/Ksh spot exchange rate specifies how much one currency, the USD, is currently worth in terms of the other, the Ksh. While the USD/Ksh spot exchange rate is quoted and exchanged in the same day, the USD/Ksh forward rate is quoted today but for delivery and paid on a specific future date (Cushman, 2003).

Hence, the study examined the relationship between stock prices and foreign exchange rate fluctuations. It delved into how such currency movements can either benefit or disadvantage firms depending on their export or import orientation, thereby influencing their stock market valuations. The investigation also considered broader factors, such as economic conditions, sector-specific impacts, and market sentiments, to grasp the complex dynamics at play. This approach underscored the necessity for investors and market analysts to keep abreast of global economic trends and exchange rate shifts, highlighting the intertwined nature of currency and equity markets in the global financial ecosystem.

1.1 Statement of the Problem.

The performance of a security market reflects the economic situation of a country. The security prices are affected by both the country's domestic economy activities and foreign economic events (Obura et al., 2013). In the aftermath of 2007-2008 post-election violence in Kenya, both the stock prices and the currency declined.The foreign exchange rate hit an all-time high of Kshs/USD107 in the year 2011 from KSh/USD 87 in the year 2010. Nairobi All Share Index (NASI) plunged 30.45 percent to 68.08 points in 2011 down from the 97.82 (KPMG, 2012). The volatility of exchange rates and fluctuations of stock prices led to big losses in investors' portfolios due to uncertainty and inefficiency of financial markets (Odoyo, Muasya, & Kipyego, 2014). Due to this, various research have been carried out to investigate the dynamic issue of the inter-temporal causality between stock returns and exchange rates, but the results are inconclusive. In addition the empirical findings provide four strings of evidence that differs sharply.

Empirical studies have shown varying results regarding the relationship between exchange rates and stock prices. Issam & Murinde (1997) and Ajayi et al. (1998) found that exchange rates Granger-cause changes in stock prices. On the other hand, Tabak (2006) and Bonga-Bonga & Hoveni (2009) discovered that stock prices Granger-cause changes in the exchange rate. Bahmani-Oskooee & Sohrabian (2011) and Pan et al. (2000) observed a bidirectional causality between these variables. However, some studies, such as Ajayi (1998), found no evidence of causality between exchange rates and stock prices. Additionally, a study conducted in Kenya by Kisaka and Mwasaru (2012) concluded that exchange rates Granger-cause stock prices, but it used the Nairobi 20 Share Index, which may not accurately reflect market performance. Moreover, this study covered the period from May 1993 to May 1999, failing to capture trends in the last eight years, a time of significant exchange rate volatility in Kenya (Kisaka & Mwasaru, 2012; Ramasamy & Yeung, 2001; Agrawal et al., 2010).

The study thus examined the effect of foreign exchange rate fluctuations on stock prices, aiming to unravel the complex dynamics that govern this relationship in the global financial markets. By focusing on how these currency movements impact the valuation of companies, especially those engaged in international trade, the research provides pivotal insights for investors, financial analysts, and policymakers. It highlights the necessity of incorporating currency risk into investment decisions and strategic planning and underscores the interconnectedness of global economic factors. This investigation not only contributes to a more nuanced understanding of financial market behaviors but also aids in the development of more robust economic and monetary policies, making it a crucial endeavor for those looking to navigate the intricacies of international finance.

1.2 Research Objective

The objective of the study was to investigate the dynamic response of stock prices to changes in foreign exchange rate.

2.0 Literature Review

2.1 Theoretical Literature.

The study was based on three theories namely goods market theory, portfolio balance approach and arbitrage pricing theory.

2.1.1 Goods Market Theory

The goods market theory, also known as the Flow-Oriented Model or Traditional Approach, posits that exchange rate movements have a direct impact on stock price changes (Donbursh & Fisher, 1980). According to the model, a country's current account is a significant determinant of the exchange rate for a particular currency. In line with this notion, the exchange rate depends on the state of the asset markets at a particular moment. However, the current account also plays a crucial role in determining the net asset position as well as influencing the asset markets. Thus, movements in stock prices may affect the exchange rate (Rahman & Uddin, 2009). The theory assumes that the appreciation of a local currency leads to disadvantages for exporters, making the shares of such firms less desirable. This can negatively affect the stock market, especially if the country relies on exports for a stable economy. Consequently, the exchange rate and the stock market become directly linked (Tian, Gary, Ma, 2010)."

2.1.2 Portfolio Balance Approach

The portfolio balance approach, also known as Stock-Oriented Model asserts that causality runs from the share market to the exchange rate. According to Branson, Halttunen, and Masson (1977), portfolio balance theory (stock oriented) postulate that the exchange rates are directly affected by the stock prices. The portfolio balance approach primarily deals with the role of capital account performance. The demand and supply condition is still applicable in the determining of exchange rates. Foreign investors would be easily attracted by a bloom stock market which means consistent capital flow causing an increase in the value of the country’s currency. Likewise, the opposite would be felt like a fall in stock prices caused by foreign investors selling their shares to prevent further losses. Additionally, to finalize the shift from the country, foreign investors convert their cash to exchange (Branson et al., 1977). This would lead to a depreciation in the local currency caused by the increase in demand for the foreign currency.

A rise in stock prices leads to a corresponding appreciation in exchange rates and vice versa. In the portfolio stock oriented models, it is stipulated that movements in stock movements mean a corresponding shift in the exchange rate through the capital account transactions. The extent to which the stock oriented models show how practical stocks in the real world and currency markets react depends on stock market liquidity as well as market segmentation. For instance, illiquid markets are known to make it cumbersome for investors to trade on the stock exchange market. On the other hand, segmented markets accommodate constraints like government policies on investments, overpriced transactions costs, and major foreign currency risks, all of which have been deemed to discourage or slow foreign investment (Cushman, 2003).

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2.1.3 Arbitrage Pricing Theory

The Arbitrage Pricing Theory (APT) is a financial theory that links stock prices with other macroeconomic variables. It is a multifactor model that was formulated by Ross in 1979. The APT model stipulates that various risk that are conveyed by macroeconomic factor have any effect on stock return. Conversely, it tries to capture non-market effects that cause financial assets to change. It is a multifactor model that rely on one price law and assumes that the stock return is linear to macroeconomic factors. The APT model is based on the arbitrage concept that assert; if capital market is efficient and there exist two similar assets with identical risk and return, then the selling price of an asset should be the same. Markedly, arbitrage profit can be made if there is simultaneous buying and selling of the assets; as a result, the prices of the identical asset will settle to equality due to arbitrage process.The Arbitrage Pricing Theory (APT) that assumes that the rate of return on any security is a linear function of k factors (Ross, 1976). The model is formulated as;

$$R_i = \lambda_0 + \beta_{i1}\lambda_1 + \beta_{i2}\lambda_2 + \ldots\ldots + \beta_{ik}\lambda_k + \varepsilon_i \qquad i=1, 2\ldots, n \qquad \ldots\ldots\ldots\ldots\ldots 2.1$$

The APT model shows that the rate of return (R_i) is a linear function of k macroeconomics factors (λ_k) with k sensitivities (β_k).

2.2 Empirical Review

Ajayi and Mougoue (1996), investigated the short-run and long-run relationship between stock prices and exchange rates in eight advanced economies (Canada, Germany, France, Italy, the Netherlands, the United Kingdom and the United States). The results on short-run effects in the U.S. and U.K. markets found out that an increase in stock prices causes the currency to depreciate for both the U.S. and the U.K. Issam and Murinde (1997), studied the causal relationship between exchange rates and stock prices in India, Korea, Pakistan, and the Philippines. They tested for cointegration between exchange rates and stock price index. They found that the two variables were co-integrated in the Philippines and India. They applied Granger-causality tests in Korea and Pakistan where exchange rates and stock prices were not co-integrated and Error-Correction Model in the Philippines and India where the two variables were cointegrated. Among the findings of interest were that exchange rates granger-cause stock prices in Korea, Pakistan, and India, whereas share prices granger-cause exchange rates in the Philippines (Kisaka & Mwasaru, 2012).

An analysis by Ajayi, Friedman, and Mehdian (1998) looked into the relationship between exchange rates and stock prices in the developing nations against the developed countries. Notably, the findings of Ajayi et al. (1998), seemed to have uncovered a consistency in the connections displayed between stock prices and exchange rates among developed economies, which followed the stipulated conditions held by the portfolio model. The causality runs from the stock market to the currency market in Indonesia and the Philippines while in Korea, it runs from the exchange rate to stock prices. Contradictorily, the causality between the two variables were either way in emerging Asian Economies. However, there was no significant causal relation in Hong Kong, Singapore or Malaysia. Markedly, there existed a bi-directional causality (feedback) in Taiwan (Richard Ajayi, Friedman, & Mehdian, 1998).

Notably, Pan, Fok, and Liu (2000) discovered the effects brought about by exchange rates on stock prices in selected Asian countries between 1988 to 1998. It was reported that the interactions heightened during and after the 1997 financial crisis, concurring with Granger et al. (2000) findings. A further investigation into the Asian crisis period also reported a bi-direction causality between the variables (Pan, Fok, & Liu, 2000). Ravazzolo and Phylaktis (2005), analyzed a collection of Pacific Basin countries over 18 year period (1980-1998). Their findings suggested that the stock and foreign exchange markets bear a positive relation and the US stock market provides a platform for the formation of these links (Ravazzolo & Phylaktis, 2005).

Bonga and Hoveni (2011) researched the extent of volatility spillovers between the equity market and the foreign exchange market in South Africa. The volatility stocks derived from the average mean equation in each market were incorporated into the conditional volatility of the other market using the GARCH model. The most suitable volatility models for each market were selected based on factors such as covariance stationarity, leverage effects, and, most importantly, the persistence of variance. The results indicated a unidirectional relationship with volatility spillovers from the equity market to the foreign exchange market (Bonga & Hoveni, 2011).

3.0 Research Methodology

The methodology was presented in sections.

3.1 Research Design

The study used a non-experimental research design, since there was no control of the variables. The non-experimental research design is a research design in which variables used in the research are not manipulated nor is the environment controlled (Belli, 2008). The main objective of the study was to investigate dynamics of rates of exchange and prices of stock in NSE. The study used Granger causality and Vector Auto regression (VAR) method.

3.2 Theoretical Model

The study adopted Asset Pricing Theory (APT) in the development of the empirical model. This theory provides a linkage between stock prices and various macroeconomic factors such as interest rate, inflation, money supply, and balance of payment. The Asset Pricing Theory (APT) is a multifactor model has the assumption that the function of the rate of return on any stock is linear with k factors (Ross, 1976). The model is given by equation 3.1 below;

$$R_{it} = \lambda_0 + \beta_{1t}\lambda_{1t} + \beta_{2t}\lambda_{2t} + \beta_{3t}\lambda_{3t} + \cdots + \beta_{kt}\lambda_{kt} + \varepsilon_i \quad i = 1, 2, 3\ldots, k \ldots\ldots\ldots 3.1$$

Where; R_i is the return of asset, β_k is the coefficients of λ_k factor, λ_k are the factors, and ε_i is the random noise term.

The above equation shows that the function for rate of return (R_{it}) is a linear with k macroeconomics factors (λ_k) with k coefficients (β_k). The model shows a linear relationship between the prices of stock and the macroeconomic variables. If there are k macroeconomics

factors i.e $\lambda_1, \lambda_2, \ldots\lambda_k$ with each stock having k sensitivities ($\beta_1, \beta_2, \ldots,\beta_k$). The theoretical model can be expressed as;

$SP_{it} = \lambda_0 + \beta_{it}\lambda_{it} + \ldots + \beta_{kt}\lambda_{kt} + \varepsilon_i \qquad i = 1, 2 \ldots k$ …….…… 3.2

Where; SP_{it} is the stock price, β_{it} is the coefficients of λ_{it} factor, λ_i are the factors, and ε_i is the random noise term.

3.3 Model Specification

The empirical counterpart of equation (3.2) can be established by incorporating the exchange rate into the APT model as a significant explanatory variable. As previously noted, research conducted by Osei (2006) revealed a significant long-term relationship between the exchange rate and stock prices in Ghana. In line with the theoretical model outlined in equation (3.2), the empirical model for this study presents stock prices as a linear function of inflation, money supply, interest rates, and the exchange rate, with each factor being associated with a βk coefficient. The relationship between stock returns and macroeconomic variables can generally be expressed as follows:

SP= f (INF, EXR, TBR, MS) ……..…….... 3.3

Where SP is monthly stock price, INF is inflation rate, TRB is Treasury bill rate, and MS is the money supply and EXR is the exchange rate.

The Linear equation becomes

$SP_t = \lambda_0 + \beta_1 INF_t + \beta_2\, EXR_t + \beta_3 MS_t + \beta_4\, TBR_t + \varepsilon_t$ ……..…….3.4

Where SP_t is the stock market price at time t, λ_0 is the intercept, β is the coefficient of each macroeconomic variable, INF is inflation, EXR is the exchange rate, TBR is 91-day treasury bill rate (a proxy for interest rates), and MS is the broad money supply (M3).

3.3.1 Testing for Stationarity (Unit Root Test)

Unit root is a fundamental test performed to ensure that time series data has a constant mean and variance to avoid spurious results. Unit roots test was carried out to avoid the problem of the non-stationarity series that may lead to spurious results due to trend in the data series. The study employed Augmented Dickey-Fuller test and Kwiatkowski Phillips Schmidt-Shin (KPSS) unit root test to establish the stationarity of the time series and to determine the order of integration of variables. Using the ADF unit root tests the following equation is estimated:

$$\Delta Y_t = \alpha + \beta_t + \rho Y_{t-1} + \sum_{i=1}^{k} \delta_i \Delta Y_{t-1} + \mu_t \text{ ……..……3.5}$$

The null and alternative hypotheses tested in the study were that H_0: $\rho = 0$ and H_1: $\rho < 0$.

If the computed t-statistics is greater than the asymptotic critical values in absolute values, the null hypothesis (series contained unit root), was rejected and concluding that the series was stationary

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(Gujarati, 2004). The major weakness of ADF is that it has a lower power and hence it tends to give biased conclusion. To remedy this, the study employs KPSS to eliminates the low power which occurs in Augmented Dickey Fuller (ADF) test (Green, 2008) For the KPSS criterion, the hypothesis tests for the series was:

$x_t = \beta y_t + \varepsilon_t$……..…….... 3.6

The hypotheses test for the model:

$H_o: \sigma_e^2 = 0 \Rightarrow x_t \ \ I(0)$ Stationary

$H_1: \sigma_e^2 \neq 0 \Rightarrow x_t \ \ I(0)$ Non-stationary

If t-calculated statistics is greater than the asymptotic critical values, the null hypothesis for stationarity is rejected, concluding that the series is non-stationary.

3.3.2 Vector Autoregressive Model

The study employed Vector Auto regression (VAR) model. The compact form of a VAR model that links stock prices and selected macroeconomic variables in equation (3.3) is represented as:

$X_t = A_0 + A_1 X_{t-1} + A_2 X_{t-2} + \cdots + A_p X_{t-p} + \varepsilon_t$……..…… ..3.7

Where A_0 is n × 1 vector of constant terms, A_1, A_2,..,A_p are n × n matrices of coefficients, X_t is a n×1 vector of endogenous variables: X_t = (NASI, INF, EXR, TBR, MS) and εt is a vector of serially uncorrelated disturbance terms with a constant variance and Zero means. To estimate VAR model (3.7) a system of equation for stock prices and exchange rate was developed; where the Granger causality of the exchange rate and stock price was examined (Enders & Granger, 1998).

3.3.3 Granger Causality Test

X is said to Granger-cause Y, if Y can be better predicted using the histories of both X and Y than it can by using the history of Y alone. Granger causality is employed in situations where there is some relationship between two variables, but it is not known which variable causes the other to move. In this case, Granger causality test was employed to test the association between stock price and exchange rates (Giles, 2015).Granger causality test was done through estimation of two regression equation expressed as follows:

$SPt=\alpha+\beta_{11}SP_{t-1}+\ldots+\beta_{1p}SP_{t-P}+\beta_{11}EXR_{t-1}+\ldots+\beta_{1q}EX_{t-q}+\beta_{11}INF_{t-1}+\ldots+\beta_{1p}INF_{t-R}+ \beta_{11}TBR_{t-1} +\ldots+\beta_{1p}TBR_{t-S} + \beta_{11}MS_{t-1}+\ldots+\beta_{1p}MS_{t-U}\ \varepsilon_t$……..…….…….....… 3.8

$EXR_t=\alpha+\beta_{22}EXR_{t-1+\ldots+}\beta_{2p}EXP_{t-P}+\beta_{22}SP_{t-1}+\ldots+\beta_{2q}SP_{t-q}+\beta_{22}INF_{t-1}+\ldots+\beta_{2p}INF_{t-R}+ \beta_{22}TBR_{t-1}+\ldots+\beta_{2p}TBR_{t-S} + \beta_{22}MS_{t-1}+\ldots+\beta_{2p}MS_{t-U} + \varepsilon_t$ …… ……... 3.9

Where; ε_t is the noise error term, t-i is the time lag. Equation (3.8) postulates that current stock

price (SP) is related to past values of Exchange rate (EX) as well as past values of SP. Similarly, equation (3.9) stipulates that EX is related to past values of EX as well past values of SP. Following equation 3.8 and 3.9, the following hypothesis was be tested. The hypothesis test of equation (3.8):

H_0; EX do not Granger cause SP

H_1; EX Granger cause SP

Similarly, the hypothesis test for equation (3.9):

H_0; SP do not Granger cause EX

H_1; SP Granger cause EX

The four possible expectations are; [1] presence of unidirectional causality SP to EX, [2] presence of unidirectional causality from EX to SP, [3] SP and EX Granger cause each other, i.e., bilateral causality and [4] EX, and SP are independent of each other.

3.3.4 The Dynamics Response

Studies have found out that estimated coefficients of the VAR model have no economic interpretation because they are equal to reduced form equations. Sims (1980) came up with a method of estimating VAR coefficients to trace the dynamics path of a specific variable in a system, given a certain effect of innovation or a shock brought about by a change in a variable. The dynamic response is estimated through Variance decomposition and the Impulse Response functions (IRF). VAR model can be written in the form of Vector Moving Average (VMA) where variables may be expressed as a function of the past and current values of the error terms. The VMA representation traces out the time path of shocks on the variables in VAR (Sims, 1980b)

3.3.5 The Impulse Response Functions

The impulse responses functions was be delivered from Vector Moving Average. They link the future values of the variables to the current values of error term (Enders & Granger, 1998)

3.4 Data Type, Source and Analysis.

The study utilized secondary data for the period 2008-2015. The sources of data included the Central Bank of Kenya, Nairobi Securities Exchange, and Capital Markets Authority (CMA). The NASI share index was obtained from NSE databases and the Capital Markets Authority. The exchange rate, money supply, 91-Day Treasury Rate, and inflation rate were obtained from Central Bank statistics. The objective was to examine the dynamic response of stock prices to a one standard deviation shock in foreign exchange. To achieve this, a VAR model was estimated, and the optimal lag length was determined using the Akaike Information Criterion. A Vector Moving Average (VMA) of the VAR model, along with the subsequent derivation of impulse response functions (IRF) and variance decomposition, was used to analyze the dynamic impact of changes in exchange rates on stock prices. The dynamic response was estimated through impulse response

analysis, linking the current value of the error term to the future values of the variables in the VAR. Impulse Response Functions (IRF) mapped out the dynamic response path of a variable due to a shock in the system of variables."

4.0 Empirical Findings and Discussions

The empirical findings and discussions are presented in sections.

4.1 Data Characteristics

The study used monthly time series data for the period 2008-2015. The sources of data included Nairobi Securities Exchange, Capital Market Authority and central bank of Kenya. Data was collected for the variables including Exchange rate (EX), Nairobi All Securities Exchange (NASI), Inflation rate (INFL), Treasury Bill rates (T-Bills), and Money Supply (M3).

4.2 Descriptive Statistics for Variables

The descriptive statistics summary for the macroeconomic variables dataset is presented in Table 1.

Table 1: Descriptive Statistics for Macroeconomic Variables Data Set

	NASI	EXCHANGE RATES	91 DAY TBILL	INFLATION	M3
Mean	106.33	84.08	8.64	9.04	1575201.0
Median	97.09	84.61	8.39	7.08	1513656.0
Maximum	172.93	105.28	21.65	19.72	2650182.0
Minimum	58.42	61.10	1.60	3.18	810206.0
Std. Dev.	33.36	8.84	3.88	5.05	552743.6
Skewness	0.52	-0.04	0.98	0.84	552743.6
Kurtosis	1.97	3.51	5.10	2.32	0.342390
Jarque-Bera	8.37	1.05	32.74	12.93	6.354379
Probability	0.015	0.59	0.00	0.00	0.041703

Source: Author (2016)

Descriptive statistics give summaries about the sample and they form a fundamental basis for every quantitative data analysis. The summary of the statistical characteristic of all the variables are shown in Table 1. Sample mean, standard deviation, skewness and kurtosis, the Jacque- Bera statistics and the P- value, have been reported. The high standard deviation of stock returns (SR) implies that there was high volatility at the stock market. The actual data and refined data for estimation is attached as Appendix 1.

4.3 Stationarity Test

The study used the Augmented Dickey-Fuller test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root test to determine the stationarity of the time series and to ascertain the order of integration of the variables. Table 2 shows the results for the unit root tests.

Table 2: ADF Unit Root Test Results

Variable	Form of test	Test Statistic	ADF Asymptotic Critical Value			Conclusion
			1% level	5% level	10% level	
Exchange Rates	Intercept only	-1.162061	-3.503879	-2.893589	-2.583931	Non-Stationary
	Trend and intercept	-2.871588	-4.062040	-3.459950	-3.156109	
NASI	Intercept only	-0.997677	-3.503879	-2.893589	-2.583931	Non-Stationary
	Trend and intercept	-2.781080	-4.062040	-3.459950	-3.156109	
Inflation rate	Intercept only	-4.319833***	-3.503879	-2.893589	-2.583931	
	Trend and intercept	-4.062695***	-4.062040	-3.459950	-3.156109	Stationary
Interest Rates	Intercept only	-2.277793	-3.503879	-2.893589	-2.583931	Non-Stationary
	Trend and intercept	-2.421911	-4.062040	-3.459950	-3.156109	
Money Supply	Intercept only	2.978019	-3.503879	-2.893589	-2.583931	Non-Stationary
	Trend and intercept	-1.455593	-4.062040	-3.459950	-3.156109	

Source: Author (2016)

Note: ***stationary at 1%; ** stationary at 5%; * stationary at 10% levels of significance.

From the ADF criterion, all the variables (NASI, EX, MS, IR) except inflation rate were found to contain unit roots (non-stationary). Under the ADF test the null hypothesis for the presence of a unit root was not rejected at 5 per cent level of significance for stock prices, exchange rates, money supply and interest rate. However, the presence of a unit root was rejected at 5 per cent level of significance for inflation, meaning inflation was stationary. However, all the variables except money supply that were not stationary as per ADF tests were all found to be stationary by KPSS test which is a superior test for stationarity (Gujarati, 2004). The findings of the test are shown in Table 3

Table 3: KPSS Stationarity Tests Results

Variable	Form of test	Test Statistic	KPSS Asymptotic Critical Value			Conclusion
			1% level	5% level	10% level	
Exchange Rates	Intercept only	1.043243	0.7390	0.4630	0.3470	Stationary
	Trend and intercept	0.114640***	0.2160	0.1460	0.1190	
NASI	Intercept only	0.903606	0.7390	0.4630	0.3470	Stationary
	Trend and intercept	0.204774*	0.2160	0.1460	0.1190	
Inflation rate	Intercept only	0.297011***	0.7390	0.4630	0.3470	
	Trend and intercept	0.065395***	0.2160	0.1460	0.1190	Stationary
Interest Rates	Intercept only	0.298815***	0.7390	0.4630	0.3470	Stationary
	Trend and intercept	0.066681***	0.2160	0.1460	0.1190	
Money Supply	Intercept only	1.283437	0.7390	0.4630	0.3470	Non-Stationary
	Trend and intercept	0.291941	0.2160	0.1460	0.1190	

Source: Author (2016)

Note: ***stationary at 1%; ** stationary at 5%; * stationary at 10% levels of significance.

In the KPSS criterion, all variables, except for money supply, were found to be stationary at levels, as the computed LM test statistics were lower than the critical values needed to reject the null hypothesis at the 1%, 5%, or 10% significance levels (Judge, Hill, Griffiths, & Lee, 1985). To achieve stationarity, the money supply series was differenced once.

Table 4: 1st Difference using ADF and KPSS Stationarity Tests Results

Variable	Form of test	ADF	KPSS	conclusion
Money Supply 1st Difference	Intercept only	-9.086610***	0.409378***	Stationary
	Trend and Intercept	-9.030787***	0.435435	Stationary

Source: Author (2016)

The study found that after the first differencing of the money supply, all variables achieved stationarity. Analyses using the Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests indicated that the exchange rate, Nairobi All Securities Index, inflation rate, and interest rate were stationary at their levels, classifying them as integrated of order I (0). The money supply, however, only became stationary after first differencing, categorizing it as integrated of order I(1). Given that all variables, except for the money supply, exhibited stationarity at levels as demonstrated by the KPSS tests, the study concluded that cointegration analysis of the variables was unnecessary.

4.4 Test for Multicollinearity

According to Gujarati (2004), multicollinearity between regressors leads to inaccurate estimates since the presence of multicollinearity inflates coefficients of standard errors thereby affecting the predictors. To avoid having inaccurate estimates, correlation between regressors was done to test for multicollinearity. To affirm the absence of multicollinearity, the correlation coefficient between variables should be less than 0.8. The results of the correlation coefficients was represented by correlation matrix in Table 5

Table 5: Present Pearson's Bivariate Correlation Results

		Exchange Rates	NASI	Inflation	Interest rates	dM3
Exchange Rates	Pearson Correlation	1.000				
	Sig. (2-tailed)					
NASI	Pearson Correlation	.501**	1.000			
	Sig. (2-tailed)	.000				
Inflation	Pearson Correlation	-.220*	-.399**	1.000		
	Sig. (2-tailed)	.031	.000			
Interest rates	Pearson Correlation	.423**	.036	.396**	1.000	
	Sig. (2-tailed)	.000	.728	.000		
dM3	Pearson Correlation	.206*	.285**	-.227*	-.001	1.000
	Sig. (2-tailed)	.046	.005	.027	.992	

Source: Author (2016)

The study results, as illustrated in Table 5, revealed that the exchange rate, Nairobi All Securities Exchange, inflation rate, interest rates, and money supply were not highly correlated with any other variable. The Nairobi All Securities Exchange was moderately correlated with the exchange rate (0.50). The inflation rate showed a negative correlation with the exchange rate (-0.22) and the Nairobi All Securities Exchange (-0.4). Interest rates were positively correlated with the exchange rate (0.42), Nairobi All Securities Exchange (0.04), and inflation rate (0.40). The money supply exhibited a positive correlation with the exchange rate (0.21) and the Nairobi All Securities Exchange (0.29), but it was negatively correlated with inflation (-0.23) and interest rates (-0.001). The multicollinearity results indicated that the correlation coefficients between the independent variables were less than 0.8, confirming that there was no significant multicollinearity among the variables.

4.5 Residual Tests Results

The classical linear regression model stipulates that the regression error term must follow a normal distribution with a mean of zero and constant variance (Green, 2008). After executing the specified regression model, tests for normality, heteroskedasticity, and autocorrelation were conducted on the residuals to confirm that all the Ordinary Least Squares (OLS) assumptions were met prior to drawing any conclusions and assessing the suitability of the estimated models for forecasting purposes. A series of diagnostic evaluations were performed to verify the statistical robustness of the models (Gujarati, 2004). The subsequent sections will present the findings from the residual-based tests, model specification checks, and stability assessments.

4.5.1 Normality Test - Histogram-Normality Test

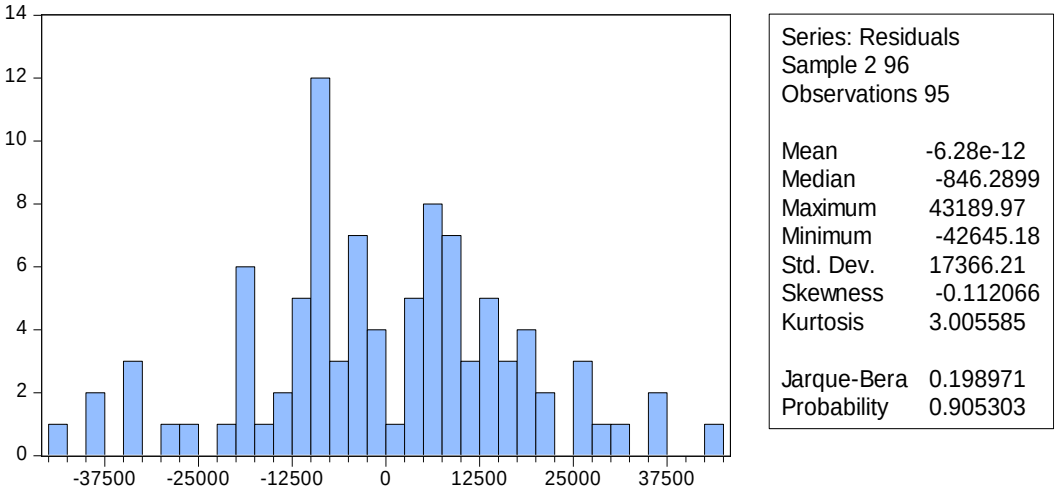

Figure 1: Jarque-Bera Test for Normality

Source: Author (2016)

The study found that one of the fundamental assumptions of a robust regression model is that the model's error term should be normally distributed. To validate the normality of the distribution, the Jarque-Bera test's probability value should exceed 0.05. The null hypothesis posited that the error term was normally distributed. The Jarque-Bera statistic was recorded at 0.1990, with a corresponding probability value of 0.9053 (90.53 percent), which surpassed the p-value threshold of 0.05 (5 percent). Consequently, the null hypothesis was not rejected, confirming that the residuals were indeed normally distributed, as depicted in Figure 1.

4.5.2 Autocorrelation Test- Breusch-Godfrey Langrage Multiplier Test

Serial correlation is present if residuals of one period are related to the residuals of the previous period. Breusch-Godfrey Serial Correlation LM to test was employed on the study to test for the presence of serial correlation. The null hypothesis for serial correlation test was stated as, H_0: There is no serial correlation. If the probability value (p-value) is greater than 5%, the null hypothesis is not rejected. The results on Breusch-Godfrey Serial Correlation LM Test are presented in Table 6

Table 6: Serial Correlation Tests Results

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	12.07	Prob. F(4,89)	0.0000
Obs*R-squared	0.35173	Prob. Chi-Square(2)	0.00452

Source: Author (2016)

Since the probability value is less than 5 percent, the null hypothesis of no serial correlation is rejected, concluding there is presence of serial correlation. Thus, to correct for presence of serial correlation, the study employed HAC (Newey-West) standard errors to correct for serial correlation.

4.5.3 Heteroskedasticity Test- Breusch-pagan Langrage Multiplier Test

Heteroscedasticity transpires when the variance of the residuals in a model is not constant. Breusch-Pegan-Godfrey test was employed to test for the presence of Heteroscedasticity. The null hypothesis for the test, H_0: Variance is constant (homoscedasticity). If the probability value (p-value) is greater than 5 percent, the null hypothesis is not rejected. The results are presented in Table 7

Table 7: Heteroskedasticity Test Results

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	1.761849	Prob. F(4,90)	0.1435
Obs*R-squared	6.898719	Prob. Chi-Square(4)	0.1413
Scaled explained SS	3.498268	Prob. Chi-Square(4)	0.4781

Source: Author (2016)

Since the probability value is greater than 5 %, the null hypothesis of variance is constant is not rejected, concluding there is no problem of heteroskedasticity.

4.5.4 Regression Specification Error Test (RESET)

Ramsey (1969) proposed Regression Specification Error Test (RESET) to determine the departure from the classical linear regression assumptions. The model is used to detect specification errors in a model which could have been mis-specified but nonetheless give desired results. Ramsey and Alexander (1984), affirmed RESET as a test for correlation between independent variables and residuals, omitted variable problem and incorrect functional relationship in a model. In most cases

the specification errors is due to measurement errors of the independent variables and expression of the independent variable as a function of lagged values in the model. The previous diagnostic test for normality, and heteroskedasticy proved that the estimated models satisfies all the OLS assumption hence desirable. Further, Ramsey RESET test was employed to examine the estimated equation and results are presented in the Table 8

Table 8: Ramsey RESET Tests Results

Dependent Variable	No. of terms	Test statistic		Conclusion
		F-statistic	Prob. (F-stat)	
Stock Price	1	3.204392	0.0768	No misspecification error evidence
	2	2.419326	0.0949	

Source: Author (2016)

The p-values of the F-statistic for both models exceeded 0.05. Therefore, the null hypothesis, which stated that all coefficients of the fitted values were zero at a 5 percent level of significance, was not rejected for either model. Based on these results, it was concluded that there were no indications of specification errors in the two models.

4.6 The Responsiveness of the Stock Price to Changes in the Exchange Rates

The objective of the study was to analyze the dynamic impact of the stock prices due to shock in exchange rates. This was achieved by running a VAR estimation and further derivation of impulse response functions of stock price. The forecasting was done over a ten-year time horizon.

4.6.1 Estimation Results for VAR Model and the Impulse Responses

The VAR model was estimated and is presented. However, in line with Sims (1980), the VAR estimates should not be interpreted in the same manner as ordinary least square estimates since they are not derived from structural equations. As Enders (1995) stated, the estimated coefficients of the VAR are considered to have limited meaning because they lack a theoretical foundation. Nonetheless, these coefficients are valuable for the derivation of impulse response functions and forecasting error decompositions. The conducted impulse response analysis connects the current value of the error term with the future values of the variables, while Impulse Response Functions illustrate the dynamic response path of a variable due to a shock in that variable. The derived impulse responses summarize the impact of shocks to exchange evolution and trace the dynamic responses of stock prices over a ten-year period following an initial one standard deviation positive shock to exchange rates. Figure 2 depicts the response of stock prices to changes in exchange rates.

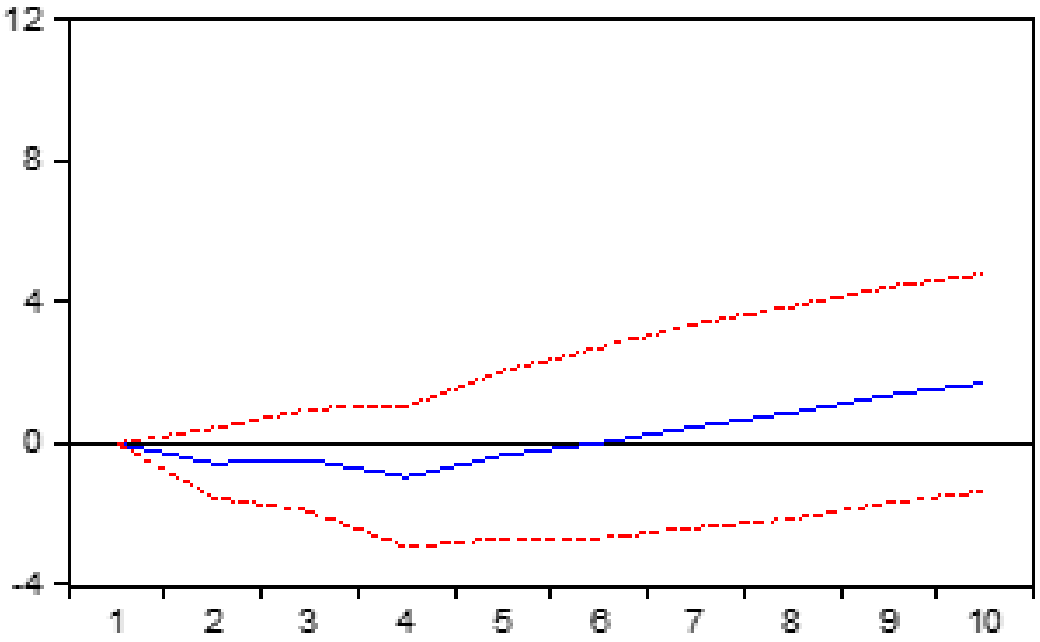

Figure 2: Response of stock prices to exchange rate
Source: Author (2016)

The study found that a one standard deviation shock to exchange rates leads to an unstable impact that converges to zero after six years, beyond which it remains within a positive range relative to stock prices. It would take nearly six years for the effects of a one standard deviation shock in exchange rates to dissipate. The initial impact is negative for the first six years, followed by a positive impact for the subsequent four years, indicating that the exchange rate exerts a mixed effect on stock prices, and this effect has a prolonged presence in the economy. The ultimate impact is contingent upon the appreciation or depreciation of the Kenyan shilling against the US dollar. Should the Kenyan shilling depreciate against the US dollar, the resultant effect would be negative, leading to a decline in stock prices. The results are at par with the findings of Dimitrova (2005), who found out that currency depreciation results to stock prices decline in US. The author explains that depreciation leads to high inflation, which makes investors to be skeptical about companies, thus stock prices fall (Dimitrova, 2005). In addition, the findings are also consistency with study carried out on five emerging East Asian stock market. The study found out that currency depreciation negatively affect stock market return in East Asian emerging Economies (WenShwo & Stephen, 2002).

5.0 Conclusion

The study concludes that the impact of unexpected changes in the exchange rate persisted for a long period in the economy before eventually diminishing. This was specifically observed in the stock prices at the Nairobi Securities Exchange. The analysis revealed that a one standard deviation shock to the exchange rate has a mixed effect (both negative and positive), and this effect is felt for a long time in the economy. The study found that the exchange rate has a significant impact on

stock prices in Kenya. Exchange rate fluctuations have a significant and prolonged impact on stock prices, with effects that can last for several years. This highlights the importance of incorporating currency risk management into investment strategies and economic policy formulation to mitigate adverse impacts and capitalize on potential opportunities.

6.0 Policy Recommendations

The study recommends that investors and policymakers should adopt a long-term perspective when considering the impact of exchange rate fluctuations on stock prices, given the extended period over which these effects materialize. There is a need for robust risk management strategies that account for potential volatility in the market. For investors, diversifying portfolios to include assets less sensitive to currency risk might mitigate adverse impacts. Policymakers should consider measures to stabilize the local currency and shield the economy from negative external shocks. Additionally, the study recommends that companies engaged in international trade should implement financial instruments such as forwards and options to hedge against exchange rate risks. Given the initial negative impact followed by a long-term adjustment, these stakeholders should prepare for short-term market uncertainties while positioning themselves to capitalize on potential long-term gains. This approach aligns with the observed pattern where stock prices eventually stabilize and turn positive after initial volatility, highlighting the importance of resilience and strategic planning in the face of exchange rate shocks.

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