Macroeconomic Factors and Stock Price Volatility at Nairobi Securities Exchange

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ABSTRACT

The stock price volatility has been a problem in stock markets affecting the stock returns of firms listed at Nairobi Securities Exchange (NSE). Although some scholars have focused on the issue of high share price volatility, the issue persists and still hinders the development of the market. This study main objective is to determine the effects of macroeconomic factors on volatility of stock prices of stock market in Kenya. The specific objectives are; to establish the effects of inflation on stock prices of stock market in Kenya; to establish the effects of interest rates on volatility of stock prices of stock market in Kenya; and to establish the effects of exchange rates on stock prices of stock market in Kenya. The research was anchored on four theories and two models namely the Arbitrage pricing theory, Modern portfolio theory, information cascade theory, Fisher’s theory, Efficient market hypothesis and present value model. The research applied a causal research design, which followed the positivism philosophy of research and knowledge creation. The study focused on analyzing the effects of macroeconomic factors on volatility of stock prices of the NSE 20 share index in Nairobi Securities Exchange over a period ranging from 2009 to 2021. The design allowed collection of monthly data on the study variables and time series analysis of the hypothesized relationships between independent and dependent variables and conducted both descriptive statistical analysis and inferential statistical analysis. Descriptive statistical analysis involved generation of central tendency statistics such as mean, minimum and maximum points of the data as well as standard deviations to show the spread of the data from the mean. The inferential statistical analysis utilized in this study was Error Correction Model, guided by the results of cointegration tests. From the descriptive statistical analysis, the study found that between 2009 and 2021, interest rates demonstrated an average of approximately 9.155, inflation averaged around 150.916, foreign exchange rate maintained an average of roughly 94.219, and stock price volatility averaged 0.4%. The Error Correction Model revealed that, interest rates have no significant effect on stock price volatility of NSE 20 share index (β = -0.00034, p.value = 0.805). Similarly, inflation has no significant effect on stock price volatility of NSE 20 share index (β = -0.0000394, p.value = 0.218). However, foreign exchange has negative and significant effect on stock price volatility in Kenya (β = -0.0139, p.value = 0.017). The study concluded that interest rates and inflation have no significant effect on stock price volatility in Kenyan stock market, while foreign exchange has inverse and significant effect on stock price volatility. Thus, the study recommends that market participants, including government, investors, traders, policy makers and financial institutions, should incorporate foreign exchange rate movements into their risk management strategies. Adequate measures and policies such as market circuit breakers and enhanced risk management protocols should be in place to ensure smooth market operations and prevent any disruptions due to changing foreign exchange dynamics.

Keywords: Macro-Economic Indicators, Stock Price Volatility, Stock Market, Inflation, Interest Rates, Foreign Exchange
INTRODUCTION

1.1 Background of the Study
Globally, macroeconomic developments are emphasizing on strong concerted efforts to harmonize economic development through paradigm shift in monetary and fiscal policies of various nations across the world. This becomes more evident in progression of economic production with stock prices review since the onset of global financial crisis of 2008 as depicted by (Dempsey, 2022). Interestingly, the developing economies have proved to be more resilient during the global financial crisis linked to smaller economic sizes and less complex financial system as opposed to the developed countries. However, emerging markets face challenges due to their reliance on foreign capital and less stable stock market structures (Koepke, 2019).

The study highlights the volatility and uncertainty in emerging markets' stock prices, which can deter investors. It emphasizes the importance of stable monetary policies to attract investment and maintain economic growth. The study by Zhang, Zhou, & Xiong, (2019). indicated that China's stock price volatility was greater than that of the US and Japan, but less impacted by the 2008 crisis due to Chinese government policies. Subsequent changes in macroeconomic policy in China, Japan, and the US have led to increased stock prices.

Macroeconomic factors like interest rates, money supply, inflation, and exchange rates significantly impact stock prices. Bhuiyan and Chowdhury (2020) found that US stock indices were negatively influenced by interest rates but positively affected by money supply. In developing economies like Argentina, Indonesia, India, and South Africa, factors such as economic growth, trade openness, and stock market liquidity drive stock market development.

The study also explores the effects of inflation on stock prices (Amanda, Akhyar, & Ilham, 2023). High inflation erodes purchasing power, leading to market uncertainty and volatility, as seen in the Nairobi Securities Exchange (NSE) from 2010 to 2020. Rising inflation rates can cause shifts from equities to bond markets, impacting stock prices. Ultimately, the document suggests that maintaining stability through effective macroeconomic policies is crucial for a thriving stock market. Macroeconomic factors are pivotal indicators of overall economic performance, reflecting shifts in national or global economies such as inflation, interest rates, unemployment, and GDP (Mügge, 2016). These factors directly impact stock market prices and consequently affect the broader population. Financial stability is intricately linked with macroeconomic policies, particularly during financial crises, highlighting the importance of government interventions and regulatory frameworks (Kawai, & Prasad, 2011).

Stock prices are influenced by various macroeconomic variables and financial intermediaries, making them complex to observe (Bond, Edmans, & Goldstein, 2012). Fluctuations in stock prices, as seen in the Nairobi Securities Exchange (NSE), can pose challenges for investors and market stability. Understanding the determinants of stock market volatility, including interest rates, inflation, and exchange rates, is crucial for policymakers to forecast market trends and manage risks (Amanda, Akhyar, & Ilham, 2023).

The NSE 20 share index, tracking the performance of the top 20 companies listed on the NSE, serves as a significant indicator of the Kenyan economy's health and investor sentiment. However, individual company performance within the NSE varies due to diverse factors such as operational efficiency and business strategies (Bhuiyan & Chowdhury, 2020).

As the NSE 20 share index performance declines over time, there's a need to investigate factors influencing share liquidity and market volatility. The Asset Pricing Theory suggests that macroeconomic variables contribute to stock market volatility, although it doesn't specify which factors are most influential (Otajah, 2020). Therefore, research focusing on interest rates, inflation,
and foreign exchange rates' impact on stock price volatility at the NSE is essential for improving market performance and investor confidence (Koepke, 2019).

1.2 Statement of the Problem

Stock market volatility in Kenya has increased, with 16.96% in 2020 compared to 14% the year before. Although volatility can be beneficial, excessive and unpredictable fluctuations can lead to risk and uncertainty, making it challenging for investors to anticipate future returns. Investors tend to avoid volatile stocks due to their unpredictable price swings, while moderate volatility can benefit long-term investors through buying low and selling high (Mugendi, 2024).

Macroeconomic variables like inflation, interest rates, and foreign exchange rates play a significant role in stock market volatility (Kuria, Oluoch, & Memba, 2024). Changes in these indicators can impact company profitability, investor behavior, and overall market stability. Studies in Kenya have shown varying results on the effects of these macroeconomic factors on stock market performance (Muriuki, P. K. (2014); Khalid, (2017). For example, inflation and interest rates are generally linked to increased stock market volatility, while GDP and exchange rates have shown inconsistent correlations. Global studies offer mixed results, with some indicating positive relationships between macroeconomic variables and stock prices, while others suggest inverse or negative correlations (Harcourt, 2017). Given these divergent outcomes, a new study is warranted to understand the impact of macroeconomic variables on Kenya's stock market volatility. Previous studies often used short data series, which could affect their reliability. Therefore, the study aims to address these limitations by using time-series data from 2009 to 2021, encompassing recent events like the COVID-19 pandemic. By examining more extensive and recent data, this research hopes to provide clearer insights into how macroeconomic variables influence stock market volatility in Kenya.

1.3 Objectives of the Study

1.3.1 General Objectives of the Study

The general objective of the study was to establish the effects of macro-economic indicators on stock price volatility of Stock Market in Kenya.

1.3.2 Specific Objectives of the Study

The specific objectives were:

1. To establish the effect of inflation on stock price volatility of Stock Market in Kenya.
2. To assess the influence of interest rates on stock price volatility of Stock Market in Kenya.
3. To determine the effect of foreign exchange on stock price volatility of Stock Market in Kenya.

1.4 Research Questions

The study sought to answer the following research questions:

1. What is the effect of inflation on stock price volatility of Stock Market in Kenya?
2. What is the impact of interest rates on stock price volatility of Stock Market in Kenya?
3. What is the influence of foreign exchange rate on stock price volatility of Stock Market in Kenya?

1.5 Scope of the Study

The study focused on analyzing the effects of macroeconomic variables on volatility stock prices of the NSE 20 share index in Nairobi Securities Exchange. The study focused on these 20 firms over a period ranging from 2009 to 2021. This period is selected because it will be able to capture the changing economic conditions, thus allow to determine how the changes of macroeconomic indicators affect the changes in stock prices. The research followed a positivism approach to adopt time series data for the period ranging from 2009 to 2021 and obtained monthly data on daily stock
prices, consumer price index, central bank rate (CBR) and USD to Ksh rate obtained from NSE, KNBS, and CBK respectively. The study relied on time series methods of data analysis.

LITERATURE REVIEW

2.1 Theoretical frameworks
Theoretical frameworks offer a structure for research studies by outlining relationships between theories and the variables examined. Zhang, Zhou, & Xiong, (2019) explained that a theoretical framework connects theories to variables investigated in an analysis. This summary reviews key financial theories: Efficient Market Hypothesis (EMH), Arbitrage Pricing Theory (APT), and Modern Portfolio Theory (MPT), exploring their relevance to financial studies.

2.1.1 Efficient Market Hypothesis (EMH)
Developed by Eugene Fama in 1970, EMH posits that stock prices fully reflect all available information, making it difficult to predict price movements for profit. Mendy (2012) refined EMH by identifying three forms of market efficiency: weak, semi-strong, and strong. Weak form reflects past information; semi-strong form rapidly adjusts prices to new information; and strong form encompasses all public and insider information (Delcey, 2018). The semi-strong form, where current asset prices integrate all past publicly available information, serves as the study's focus for examining the predictability of stock prices based on macroeconomic variables. Various studies have used EMH to assess stock market behavior in different contexts.

2.1.2 Arbitrage Pricing Theory (APT)
Introduced by Stephen Ross in 1976, APT models expected returns as a linear function of macroeconomic factors or market indices, with sensitivity to changes represented by factor-specific beta coefficients. Chen, Ross, and Roll (1988) revised APT by incorporating macroeconomic elements to explain financial asset returns (Dolinar, Orsag, & Suman, 2015). APT emphasizes that the derived rate of return should accurately reflect asset pricing, correcting price divergences through arbitrage transactions. This theory's relevance to the study lies in its potential to determine the proper pricing of financial assets based on expected returns. APT has been used to study various financial relationships, including bank performance and manufacturing firms' price volatility in relation to macroeconomic factors.

2.1.3 Modern Portfolio Theory (MPT)
Markowitz (1952) proposed Modern Portfolio Theory to reduce portfolio risk through diversification while maximizing returns. Modern Portfolio Theory focuses on analyzing interactions among securities in a portfolio rather than individual investments (Kevin, 2022). This approach emphasizes managing anticipated risks by diversifying assets. The theory's relevance lies in its application to determine risk factors affecting price volatility in manufacturing sectors (Tang, & Musa, 2011). Modern Portfolio Theory has been used in studies across various countries to understand how investors manage risks amid uncertain returns (Ilmanen, 2022). These theoretical frameworks offer valuable insights into financial market behavior and risk management, providing a basis for further investigation into financial asset pricing and stock price predictability based on macroeconomic variables.

2.1.4 Present Value Model
The Present Value Model (PVM) asserts that a stock’s intrinsic value is derived from the present value of expected future cash flows to shareholders (Rivera, Martin, Marçal, & Basso, 2012). When a stock's market value differs from its intrinsic value, it creates an opportunity for investors to

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profit, leading them to trade in a way that moves share prices toward their intrinsic values (Damodaran, 2024). This market behavior fosters efficiency, where share prices reflect their fundamental worth (Marsh, & Merton, 1986). The intrinsic value is calculated based on expected future earnings and discount rates. The PVM helps explain the connection between stock market volatility and macroeconomic activities, illustrating how stock prices are influenced by broader economic trends.

2.1.5 Information Cascade Theory
According to Dang, and Lin, (2016), examines investor behavior and suggests that people tend to follow others' decisions, creating a 'herd mentality'. This theory emerges when individuals, despite having private information, make decisions based on observing others' public actions (Shantha, 2019). Such behavior can lead to significant deviations in stock prices from their economic fundamentals, resulting in excess volatility and price momentum. Information Cascades occur when investors ignore their own data and replicate the actions of others. This herding behavior can push stock prices away from their true value, as seen in the models by Avery, & Zemsky, (1994). Ultimately, it contributes to market instability and irrational market trends.

2.1.6 Fisher's Theory
Fisher's Theory, proposed by Fisher, (1930), links inflation, real interest rates, and nominal interest rates. The theory posits that nominal interest rates should equal the real rate of return plus expected inflation. In efficient markets, stock prices adjust to incorporate these rates. Fisher's Theory highlights that shares can serve as a hedge against inflation because they represent claims on real assets, which tend to retain value during periods of rising prices (Okumu, 2024).

2.2. Conceptual Framework

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>Dependent Variable</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Inflation:</strong></td>
<td><strong>Stock Price Volatility</strong></td>
</tr>
<tr>
<td>• Consumer Price Index</td>
<td>• Standard Deviation in Stock Prices</td>
</tr>
<tr>
<td><strong>Interest rates:</strong></td>
<td></td>
</tr>
<tr>
<td>• Central Bank Rate</td>
<td></td>
</tr>
<tr>
<td><strong>Foreign Exchange Rates</strong></td>
<td></td>
</tr>
<tr>
<td>• Value of 1 USD in Kenya shillings</td>
<td></td>
</tr>
</tbody>
</table>

Figure 1: Conceptual Framework
Review of the study Literature

2.3.1 Inflation

Inflation is a sustained increase in the general price level of goods and services in an economy over time. In other words, it’s when the purchasing power of money decreases, causing prices to rise. In this study inflation is measured using an inflation index, namely Consumer Price Index (CPI), which tracks the prices of a basket of goods and services that consumers typically purchase (Suhaibu et al., 2017).

2.3.2 Interest Rates

Interest rates refer to the cost of borrowing money, typically expressed as a percentage of the principal amount borrowed. They are set by central banks or other financial institutions, and can have a significant impact on the economy and financial markets. Similar to other studies (Amata, 2017; Okuta, Kivaa, Kieti, & Okaka, 2024), this study measured interest rates using central bank rates.

2.3.3 Foreign Exchange Rates

Foreign exchange rate refers to value of one currency in terms of another currency. They are determined by the supply and demand for different currencies in the global foreign exchange market. When there is a high demand for a particular currency, its exchange rate will rise relative to other currencies. Conversely, when there is a low demand for a currency, its exchange rate will fall. This study follows the study by Amata (2017) to measure foreign exchange rate as the value of 1 US Dollar in Kenya shillings.

2.3.4 Stock Price Volatility

Finally, the study dependent variable is the stock price volatility which was measured using standard deviation in stock prices. A high standard deviation indicates that the stock prices have fluctuated significantly from their average value over a certain period of time, while a low standard deviation indicates that the stock prices have remained relatively stable (Kalovwe et al., 2021).

2.4 Empirical Literature Review

2.4.1 Inflation and stock price volatility

Inflation, a key economic phenomenon, affects the general level of prices for goods and services and is closely watched by economists and policymakers. While it can have both positive and negative impacts, high inflation often disrupts economic growth and corporate activities, impacting stock prices and the broader economy.

Several studies have explored the relationship between inflation and stock prices. Suhaibu et al. (2017) highlighted that high inflation adversely impacts economic growth and business operations. Misati, Osoro, Odongo, & Abdul, (2024), found that when inflation exceeds a certain threshold, stock prices tend to decrease, impacting returns and credit market frictions. Asmy et al. (2019) observed that inflation affected stock prices among agricultural firms in the Czech Republic, while Muhammed, Desalegn, & Emese, (2024) reported a negative relationship between inflation and stock prices in Bangladesh.
In the context of larger markets, studies by Duffee (2018) and Taghizadeh-Hesary et al. (2019) found that inflation had no significant effect on stock price volatility in the U.S. and European markets, suggesting that other factors might be more influential. Similarly, Liu et al. (2022) indicated that in Southeast Asian emerging markets, inflation did not significantly drive stock price fluctuations.

Endri et al. (2020) explored the impact of various macroeconomic variables on the Indonesian stock exchange, revealing that inflation, along with other factors like interest rates and exchange rates, had a significant effect on stock prices. Sakti et al. (2017) and Nwokoye & Emanuel (2018) found that inflation positively correlates with stock prices in Jordan and Nigeria, respectively.

Finally, Ogede et al. (2020) highlighted the negative impact of oil price volatility on inflation in Africa oil-exporting countries, underscoring the complexity of factors influencing inflation and, subsequently, stock prices. Overall, while inflation has varied impacts on stock prices across different regions and industries, the broader economic context and other macroeconomic factors play a crucial role in understanding these dynamics.

2.4.2 Interest rates and stock price volatility

Interest rates play a crucial role in influencing stock prices, as highlighted by various studies across different regions and time periods. Kerioh, (2019) noted that while Central Bank of Kenya's interest rate hikes didn't have immediate effects on stock prices, they did impact commercial banks' borrowing costs, indirectly affecting stock prices. Johnson (2016) linked higher interest rates to ripple effects in the stock market, often resulting in stock price declines due to reduced equity values.

Research examining this relationship revealed mixed outcomes. Manera and Cologni (2008) found no significant link between interest rates and stock price volatility in G-7 countries, suggesting that other factors might be more critical in driving stock fluctuations. However, Ferguson, (2002), focusing on various developed and developing economies, concluded that there is a strong inverse correlation between interest rates and stock prices, indicating that controlling interest rates could positively impact stock markets through demand-pull effects.

Additionally, Amlhud & Yakov (2016) observed that sudden decreases in federal funds rates led to significant stock price spikes, suggesting that announcements about interest rate changes could create temporary volatility in the stock market. Otieno (2018), studying the Nairobi Securities Exchange, also found that bank interest rates significantly influenced stock prices, with higher rates making it costlier for firms to borrow capital, leading to reduced stock prices. Conversely, lower rates made borrowing cheaper, encouraging stock price growth. Overall, these studies demonstrate that the relationship between interest rates and stock prices can vary depending on context, with factors like monetary policy, economic conditions, and market sentiment playing crucial roles.

2.4.3 Foreign Exchange rate and stock price volatility

Globalization has greatly influenced business operations, with international trade playing a key role in driving currency exchange activities. Exchange rates, which indicate the relative value of one currency against another, impact the economy by affecting domestic prices, trade profitability, resource allocation, and investment decisions. The stability of exchange rates is crucial for economic health, while fluctuations can disrupt market conditions.
Multiple studies have explored the relationship between exchange rates and stock prices across different regions. Mitter (2002) studied this relationship in East Asian countries after the 1997 financial crisis, revealing varying outcomes. For example, fluctuating exchange rates negatively impacted stock prices in Thailand and Japan, while Hong Kong saw an inverse correlation where stock prices influenced exchange rates. The Philippines and Singapore exhibited a bidirectional relationship, while Taiwan showed no significant pattern.

In Guinea, Jefry & Djazuli (2020), found a linear relationship between exchange rates and stock prices in the manufacturing sector. Meanwhile, Muraguri, (2016) in Kenya observed that exchange rate variations significantly impact stock prices for firms listed on the Nairobi Securities Exchange. This impact is linked to how currency appreciation or depreciation affects export competitiveness and profitability. Sakwa (2022) noted that a stronger local currency makes exports more expensive, reducing competitiveness and, consequently, stock prices for export-oriented firms. However, import-oriented firms benefit from a stronger local currency, leading to increased stock prices due to higher profit margins. These studies collectively demonstrate the complex interplay between exchange rates and stock prices in different markets and economic contexts.

**RESEARCH METHODOLOGY**

The research design chosen for this study is causal, aiming to establish cause-and-effect relationships between variables. Employing quantitative secondary data from 2009 to 2021, the study focuses on constituent firms listed in the Nairobi Securities Exchange (NSE) 20 share index. The sampling frame comprises the list of NSE 20 constituents, facilitating data collection. Utilizing a census survey method, the study collects data from audited annual financial reports of listed companies, the Central Bank of Kenya (CBK), and the Kenya National Bureau of Statistics (KNBS). Data analysis involves preliminary tests for linearity, multicollinearity, heteroskedasticity, autocorrelation, stationarity, and cointegration. Descriptive statistics provide summaries of the data, while a quantitative model, such as Autoregressive Distributed Lags (ARDL) or Error Correction Model (ECM), is employed to test hypotheses and generate inferences regarding the relationships between variables. The choice between ARDL and ECM depends on the results of cointegration tests, ensuring robust modeling of time-dependent data.

\[
Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 X_{1t} + \beta_3 X_{2t} + \beta_4 X_{3t} + u_t \quad (3.4)
\]

\[
Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 X_{1t} + \beta_3 X_{2t} + \beta_4 X_{3t} + \lambda ECT_{t-1} + u_t \quad (3.5)
\]

Where,
- \(X_1\) is the interest rate variable (CBR)
- \(X_2\) is the inflation rate variable (CPI)
- \(X_3\) is the foreign exchange variable (KSH/USD)
- \(Y\) is the dependent variable stock price volatility.
- \(Y_{t-1}\) is the first lag of \(Y\) (Stock price volatility).
- ECT is the error correction term extracted residuals from the regression of the long-run equation.
- \(u_t\) is the residual

In model 3.4, \(\beta_2, \beta_3\& \beta_4\) denotes the short-run reaction of \(Y_t\) after a change in \(X_t\) and in model 3.5, \(\beta_2, \beta_3\& \beta_4\) denotes the long-run reaction of \(Y_t\) after a change in \(X_t\). The null hypothesis was rejected at 5% significance level, when the p-value of coefficients is less than 0.05.
DATA ANALYSIS AND DISCUSSION

4.1 Descriptive Statistical Analysis

Table 4.1 Summary Statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean</th>
<th>Std. Dev.</th>
<th>min</th>
<th>max</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interest rates</td>
<td>156</td>
<td>9.155</td>
<td>2.721</td>
<td>5.75</td>
<td>18</td>
</tr>
<tr>
<td>Inflation</td>
<td>156</td>
<td>150.916</td>
<td>39.095</td>
<td>104.66</td>
<td>381.02</td>
</tr>
<tr>
<td>Foreign exchange rate</td>
<td>156</td>
<td>94.219</td>
<td>10.636</td>
<td>74.796</td>
<td>112.788</td>
</tr>
<tr>
<td>Stock volatility</td>
<td>156</td>
<td>0.004</td>
<td>0.008</td>
<td>0</td>
<td>0.088</td>
</tr>
</tbody>
</table>

Table 4.1 provides essential insights into the characteristics of the variables under scrutiny. The dataset comprises 156 observations for each variable, yielding comprehensive summary statistics. Over the period between 2009 and 2021, interest rates exhibit an average of approximately 9.155 with a standard deviation of around 2.721, reflecting a high dispersion from the mean. This implies that interest rates have experienced significant fluctuations or variability over the period, suggesting economic instability, which can make it challenging for businesses and investors to predict and plan for future interest rate movements. Inflation, on average was 150.916 with a standard deviation of 39.095, showcasing notable dispersion. Similarly, this high dispersion reflects economic uncertainty and suggests that consumer prices have experienced significant fluctuations over the period. This can erode the purchasing power of individuals and businesses, hence affecting the stock prices and stock market volatility. The foreign exchange rate, averaging around 94.219, displays a standard deviation of approximately 10.636, implying variability in exchange rate values. The variability in exchange rate values, as indicated by the standard deviation, suggests that foreign exchange rates are subject to significant fluctuations. This can pose exchange rate risk to businesses engaged in international trade. When exchange rates are volatile, it becomes challenging to predict the cost of imports and the revenue from exports, impacting the stock market volatility. Lastly, on average the stock volatility is 0.4% with a standard deviation of 0.008, portraying fluctuation in volatility levels.

4.2 Preliminary Analysis

The study conducted preliminary analysis to examine whether conditions are right for time series regression analysis. The tests include normality, linearity, multicollinearity, heteroskedasticity, autocorrelation, stationarity and cointegration.

4.2.1 Stationarity Tests

Stationarity implies that the statistical properties of a time series, such as mean and variance, remain constant over time. The study used Augmented Dickey Fuller (ADF) test to examine stationarity when constant term is suppressed, trend and drift term and the findings are presented in Table 4.3.

Table 4.2 Stationarity Tests Results

<table>
<thead>
<tr>
<th>Variable</th>
<th>Option</th>
<th>Test statistic</th>
<th>1% critical value</th>
<th>5% critical value</th>
<th>10% critical value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock Volatility</td>
<td>No constant</td>
<td>-4.757</td>
<td>-2.593</td>
<td>-1.95</td>
<td>-1.614</td>
</tr>
<tr>
<td></td>
<td>Trend</td>
<td>-7.573</td>
<td>-4.022</td>
<td>-3.443</td>
<td>-3.143</td>
</tr>
<tr>
<td></td>
<td>Drift</td>
<td>-5.948</td>
<td>-2.351</td>
<td>-1.655</td>
<td>-1.287</td>
</tr>
<tr>
<td>CBR</td>
<td>No constant</td>
<td>-0.833</td>
<td>-2.593</td>
<td>-1.95</td>
<td>-1.614</td>
</tr>
<tr>
<td></td>
<td>Trend</td>
<td>-2.691</td>
<td>-4.022</td>
<td>-3.443</td>
<td>-3.143</td>
</tr>
<tr>
<td></td>
<td>Drift</td>
<td>-2.647</td>
<td>-2.351</td>
<td>-1.655</td>
<td>-1.287</td>
</tr>
</tbody>
</table>
As shown in Table 4.1 results of the stationarity tests suggest that the stock volatility variable exhibits stationarity when considering different options for trend components. The test statistics for all three options (No constant, Trend, and Drift) are more negative than the respective critical values at the 1%, 5%, and 10% significance levels, indicating that the stock volatility variable is stationary. However, for CBR (interest rate) the test statistics for all three options (No constant, Trend and Drift) are less negative than the respective critical values at the 1%, 5%, and 10% significance levels, hence interest rate was non-stationary at level. The study further conducted first-order differencing and the results revealed that the respective critical values at the 1%, 5%, and 10% significance levels, indicating that the first-order difference of CBR variable is stationary. For CPI, the test statistics for all three options (No constant, Trend, and Drift) are more negative than the respective critical values at the 1%, 5%, and 10% significance levels, indicating that CPI (inflation rate) variable is stationary at level. Additionally, based on the ADF test results, the foreign exchange rate series appears to be non-stationary when a constant or drift is considered, thus, the study conducted first-order differencing. Table 4.3 shows the summary of stationarity results.

Table 4.3 Stationarity Results Summary

<table>
<thead>
<tr>
<th>Variable</th>
<th>Stationary Level</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stock Volatility</td>
<td>Stationary at level</td>
</tr>
<tr>
<td>CBR (DCBR)</td>
<td>Stationary at first difference</td>
</tr>
<tr>
<td>CPI</td>
<td>Stationary at level</td>
</tr>
<tr>
<td>Foreign exchange rate (D.Fx)</td>
<td>Stationary at first difference</td>
</tr>
</tbody>
</table>

4.2.2 Linearity Tests

This research utilized histogram to examine whether the residuals exhibit bell-shaped normal curve and the findings are presented in Figure 4.2.
Figure 4.2 Linearity Tests
As shown in Figure 4.2, variables Dxrate (first order difference of foreign exchange rate) and CPI appears to have a linear relationship with stock volatility as shown by slanting fitted values, while DCBR (first order difference of interest rate) appears to have no linear relationship with stock volatility as indicated by almost flat fitted line.

4.2.3 Normality Tests
The study employed Jarque-Bera test to examine the normality of the residuals and the results are displayed in Table 4.4.

Table 4.4 Normality Test Results

<table>
<thead>
<tr>
<th>Jarque-Bera normality test:</th>
<th>Chi(2)</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jarque-Bera test for Ho: normality:</td>
<td>5.489</td>
<td>0.0643</td>
</tr>
</tbody>
</table>

Source: Author Analysis (2023).

The normality test results, as presented in Table 4.4, the p-value was greater than 0.05, suggesting that there was no strong evidence to reject the null hypothesis of normality ($\chi^2 = 5.489$, p.value = 0.0643 > 0.05). Therefore, the residuals in the data do not significantly deviate from a normal distribution based on the Jarque-Bera test.

4.2.4 Multicollinearity Test
The research utilized Variance Inflation Factors (VIF) to check for the levels of multicollinearity and the results are as shown in Table 4.5.

Table 4.5 Multicollinearity Test Results

<table>
<thead>
<tr>
<th>VIF</th>
<th>1/VIF</th>
</tr>
</thead>
<tbody>
<tr>
<td>DXrate (Foreign Exchange rate)</td>
<td>1.041</td>
</tr>
<tr>
<td>DCBR (Interest rates)</td>
<td>1.035</td>
</tr>
<tr>
<td>CPI (Inflation)</td>
<td>1.014</td>
</tr>
<tr>
<td>Mean VIF</td>
<td>1.03</td>
</tr>
</tbody>
</table>

According to Assaf et al. (2019) if the VIF value is less than 10 there is no serial multicollinearity, which can affect the calculation of standards errors. Overall, the Mean VIF value of 1.03 reinforces the observation that there is no substantial multicollinearity among the predictors. The values of VIF being close to 1 indicate that the predictors are not highly correlated with each other, which is a positive finding in regression analysis. This suggests that the chosen predictor variables do not have strong intercorrelations that could lead to unstable or biased coefficient estimates in the
regression model. Consequently, the low VIF values suggest that the predictors are suitable for inclusion in the regression analysis without raising significant concerns about multicollinearity.

### 4.2.5 Heteroskedasticity

This study used modified Breusch-Pagan-Godfrey (Breusch-Pagan) test to test for heteroskedasticity. The null hypothesis of the test provides that the data is homoscedastic (no heteroskedasticity) and the results were presented in Table 4.6.

#### Table 4.6 Heteroskedasticity Tests

<table>
<thead>
<tr>
<th>Chi2</th>
<th>P. value</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.77</td>
<td>0.0931</td>
<td>Homoscedastic</td>
</tr>
</tbody>
</table>

The null hypothesis for Breusch Pagan test for heteroskedasticity is that error terms exhibit constant variance. Table 4.5 shows that for all the four models, the p-values are greater than 0.05, hence the study fails to reject the null hypothesis and concludes that the error terms are homoscedastic.

### 4.2.6 Autocorrelation

Autocorrelation was tested using Durbin Watson and Breusch Godfrey LM test for autocorrelation. The null hypothesis of the tests asserts that the residuals are not linearly auto correlated and the findings were presented in Table 4.7.

#### Table 4.7 Autocorrelation Tests

<table>
<thead>
<tr>
<th>Test</th>
<th>d-statistic</th>
<th>chi2 (p.value)</th>
<th>Decision</th>
</tr>
</thead>
<tbody>
<tr>
<td>Durbin-Watson</td>
<td>(6,152) 2.028665</td>
<td>-</td>
<td>No serial correlation</td>
</tr>
<tr>
<td>Breusch-Godfrey LM</td>
<td>-</td>
<td>0.509 (0.4754)</td>
<td>No serial correlation</td>
</tr>
</tbody>
</table>

In Table 4.7, the autocorrelation tests are presented with relevant statistics. For the Durbin-Watson test, the calculated d-statistic is 2.028665, indicating no evidence of serial correlation. In the case of the Breusch-Godfrey LM test, the chi-squared statistic is 0.509 and the associated p-value is 0.4754. This p-value suggests that there is no significant serial correlation. Therefore, based on the results of both tests, the decision is made that there is no serial correlation present in the data.

### 4.2.7 Cointegration Tests

Since some variables were stationary at level and others were stationary after first-order differencing, the study used Johansen-Juselius (1990) to carry out the cointegration test. The findings of the test are displayed in Table 4.8.

#### Table 4.8 Johansen Cointegration Test Results

<table>
<thead>
<tr>
<th>Maximum rank</th>
<th>Parms</th>
<th>LL</th>
<th>eigenvalue</th>
<th>trace statistic</th>
<th>5% critical value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>20</td>
<td>-467.06</td>
<td>0.397</td>
<td>152.338</td>
<td>47.21</td>
</tr>
<tr>
<td>1</td>
<td>27</td>
<td>-428.52</td>
<td>0.231</td>
<td>75.26</td>
<td>29.68</td>
</tr>
<tr>
<td>2</td>
<td>32</td>
<td>-408.48</td>
<td>0.193</td>
<td>35.185</td>
<td>15.41</td>
</tr>
<tr>
<td>3</td>
<td>35</td>
<td>-392.14</td>
<td>0.016</td>
<td>2.501</td>
<td>3.76</td>
</tr>
<tr>
<td>4</td>
<td>36</td>
<td>-390.89</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.8 shows the Johansen cointegration tests results. The trace statistics to the corresponding 5% critical values in the Johansen cointegration tests provides insight into the presence of cointegrating equations among the examined variables. The null hypothesis in each case posits a maximum number of cointegrating relationships, and the comparison helps determine whether this null hypothesis can be rejected. For a maximum rank of 0, the trace statistic of 152.338 is notably higher than the 5% critical value of 47.21, suggesting that the null hypothesis of no cointegrating relationships should be rejected, hinting at the presence of at least one cointegrating equation. Similarly, for a maximum rank of 1, the trace statistic of 75.26 exceeds the 5% critical value of 29.68, offering evidence against the null hypothesis and implying the possibility of at least 2 cointegrating equations. Moreover, for a maximum rank of 2, the trace statistic of 35.185 exceeds
the 5% critical value of 15.41, offering evidence against the null hypothesis and implying the possibility of at least 3 cointegrating equations. However, for a maximum rank of 3, the trace statistic of 2.501 is less than the 5% critical value of 3.76 suggesting that there is no further evidence of more than 3 cointegrating equation. Therefore, the study rejects the null hypothesis that there is no cointegrating equation in the model, and establishes that there are 3 cointegrating equations in the model.

Cointegration implies that the variables exhibit a long run relationship and that the series can be combined in a linear fashion. It also implies that if there are shocks in the short run, it may affect the movement of the individual variables, but there will be long run convergence. Therefore, the study should estimate both the long-run and short-run model using VAR and Error Correction Model. ARDL model is chosen when cointegrating vectors are weak, that is, when there is one or zero cointegrating equations while ECM model is used when the cointegrating vectors are strong and there are more than two cointegrating equations. Thus, the study

4.3 Quantitative Model

Since the Johansen Cointegration tests revealed that there are three cointegrating equations (there is long-run relationships), the study examined the Error Correction Model. The Error Correction Model (ECM) is primarily used to analyze the short-term and long-term relationships between variables in a time series framework. ECM assumes that there is a long-term equilibrium relationship (cointegration) between the variables under investigation. This implies that although individual variables may be non-stationary, linear combinations of them are stationary, suggesting a stable long-term relationship. The ECM introduces an error correction term (ECT) that captures the adjustment process when deviations from the long-term equilibrium occur. This term represents the short-term dynamics of the model and shows how quickly the system corrects itself in response to short-term shocks. The following model guides the analysis and the findings are presented in Table 4.9.

\[ Y_t = \beta_0 + \beta_1 Y_{t-1} + \beta_2 X1_t + \beta_3 X2_t + \beta_4 X3_t + \lambda ECT_{t-1} + u_t \] (4.1)

| Table 4.9 Error Correction Model Regression Results |
|-----------------|-----------------|-----------------|-----------------|-----------------|
| Number of obs   |                 |                 |                 | 155             |
| R-squared       | =               | 0.4214          |                 |
| Adj R-squared   | =               | 0.4015          |                 |
| Root MSE        | =               | 0.0075          |                 |
| Log likelihood  | =               | 531.931         |                 |

| D.Volatility    | Coef.           | Std. Err.       | t               | P>|t|  |
|-----------------|-----------------|-----------------|-----------------|-------|
| ADJ VolatilityL1.| -0.6132         | 0.100075        | -6.13           | 0     |
| LR              |                 |                 |                 |       |
| D.CBR           | -0.00034        | 0.00138         | -0.25           | 0.805 |
| CPI             | -3.90005        | 3.180005        | -1.24           | 0.218 |
| DXrate          | -0.0139         | 0.006893        | -2.01654        | 0.017 |
| SR              | -0.212          | 0.0801          | -2.65           | 0.009 |
| _cons           | 0.006           | 0.003           | 1.95            | 0.053 |

Where, D.volatility is the first-order difference of stock volatility, ADJ is the error correction term, LR is the Long Run model, D.CBR is the first-order difference of interest rates (Central Bank
The ECM Regression results are presented in Table 4.9. The analysis, conducted on a dataset of 155 observations, yielded an adjusted R-squared value of 0.4015, indicating that approximately 40.15% of the variability in the stock volatility can be explained by variables in the model namely interest rates, inflation and foreign exchange. The model’s log likelihood stands at 531.931, indicating the overall goodness of fit. ADJ displays the error correction term and the coefficient determines the speed of adjustment towards the long-run equilibrium. The deviations of from the long-run equilibrium are corrected gradually by the ECT through a series of partial short-run adjustments. The coefficient of -0.613 reveals that, after accounting for other factors, a unit change in the error correction term corresponds to a reduction of about 0.613 units in the stock volatility. The ECT is statistically significant at 5% significance level (β = 0.613, p.value = 0.0001), suggesting that 61.3% of the discrepancy between long-run and short-run is corrected within a month. In the short run, the lagged difference of volatility has a coefficient of -0.212 and a p.value of 0.009, suggesting that previous stock volatility has significant and negative effect in current stock volatility, further proving the correction.

The long-run model shows the coefficient of -0.00034 implies that a one-unit change in the first-order difference of interest rates (D.CBR) is linked to a decrease of 0.00034 units in the dependent variable. This relationship, however, is not statistically significant as the associated p-value is 0.805. Moreover, the coefficient of -0.000394 suggests that a unit increase in inflation (CPI) is associated with a decrease of approximately -0.000394 units in the dependent variable. This effect, however, is not statistically significant given the p-value of 0.218. In addition, the foreign exchange rate coefficient of -0.0139 indicates that a percent increase in foreign exchange rate results to 0.0139 percent decrease in stock volatility and the relationship is statistically significant with a p-value of 0.017. Given the results, the following is the optimal regression equation.

\[ Y_t = 0.006 - 0.212Y_{t-1} - 0.0139X_{t-1} + 0.613ECT_{t-1} + u_t \]  

(4.2)

4.4 Discussion of the Findings

4.4.1 Effect of Inflation on Stock Price Volatility

The first research question was “what is the effect of inflation on stock price volatility of stock market in Kenya?” To answer the research question, the study calculated monthly stock price volatility data from NSE20 share index from historical prices and data on inflation was obtained from KNBS. The study conducted regression analysis based on Error Correction Model. The findings indicated that inflation has no statistically significant effect on stock price volatility of NSE 20 share index in Kenya (β = -0.000394, p.value = 0.218). Thus, the study finding answers the research question that, while inflation negatively affects the stock price volatility of NSE20 share index, the effect is infinitesimal and insignificant. This may suggest that there is no linear relationship between inflation and stock price volatility of stock market in Kenya, which may suggest other forms of relationship such as non-linear relationship. In addition, while conventional economic theory suggests that higher inflation rates might lead to increased uncertainty and thereby affect stock prices, real-world dynamics can be more complex. In this specific context, the stock market in Kenya might be influenced by a combination of factors beyond inflation, such as market sentiment, macroeconomic conditions, investor behavior, and global economic trends. Furthermore, other underlying economic factors and market-specific conditions might be playing a more influential role in determining stock price volatility. Factors like corporate earnings, geopolitical events, and investor sentiment can collectively contribute to the observed volatility levels.

Similarly, the empirical studies support the finding that there is no significant linear effect of inflation on stock price volatility. For instance, Duffee (2018), Liu et al. (2022) and Taghizadeh-
Hesary et al. (2019) who established that inflation has no statistically significant effect on price volatility of the studied markets. The similarity could be influence to the fact that the authors examined the contemporaneous effects of inflation on the stock price volatility. Among the studies discussed, the work of Suhaibu et al. (2017) reinforces this finding by suggesting that inflation is a general increase in prices rather than isolated fluctuations in specific products, hence does not influence stock price volatility. Similarly, Endri et al. (2020) found that inflation has no significant effect on Dow Jones Industrial Average (DJIA), and Financial Times Stock Exchange 100 (FTSE100) stock prices. Mbuba (2017) was also in tandem with the study finding suggesting that the effects caused by high inflation rates are not evenly distributed and can have adverse effects from one firm to the other.

4.4.2 Effect of Interest Rates on Stock Price Volatility

The study sought to answer the following research question: what is the impact of interest rates on stock price volatility of Stock Market in Kenya? The study found that interest rates also have no significant effect on stock price volatility in NSE 20 share index in Kenya (β = -0.00034, p.value = 0.805). Although the effect was negative, it was statistically insignificant and small. This may suggest that interest rate has other relationship with stock price volatility, such as non-linear quadratic relationship. In addition, while the information cascade theory and efficient market hypothesis suggest that changes in interest rates should be reflected in stock prices, the volatility of the stock prices might not be influenced by such changes because the market’s behavior is also shaped by investor sentiment, other macroeconomic conditions, and corporate performance of the NSE 20 share index constituent firms. Thus, the muted effect of interest rates on stock price volatility could be attributed to the intricate interplay of these factors.

Several empirical studies are in also in tandem with that finding. Tariq et al. (2021) study found evidence of a nonlinear and inverse relationship between share prices on the Bogota stock market and interest rate as measured by the inter-bank loan interest rate. In addition, Amlhud & Yakov (2016) found that interest rates only affected the stock price volatility during the day of announcement, whereby prices exhibited slippage and huge spikes. These studies further confirm that the relationship between interest rates and stock price volatility may be non-linear and that the volatility may be influenced more by the changes in NSE 20 share index constituent companies’ fundamentals.

4.4.3 Effect of Foreign Exchange Rates on Stock Price Volatility

The study sought to answer the following research question: what is the influence of foreign exchange rate on stock price volatility of Stock Market in Kenya? The study found that foreign exchange rates has negative and significant effect on stock price volatility in NSE 20 share index in Kenya (β = -0.0139, p.value = 0.017). Specifically, the negative effect suggests that as foreign exchange rates increase or strengthen, stock price volatility tends to decrease. In other words, a more stable or favorable foreign exchange environment corresponds to reduced fluctuations in stock prices.

This finding supports the Arbitrage Price Theory (APT) which contends that asset prices are influenced by multiple macroeconomic factors, which contribute to the overall risk and return of a portfolio. If foreign exchange rates exert a significant influence on stock price volatility, APT suggest that investors would demand a higher risk premium for bearing the volatility associated with exchange rate changes. The negative and significant effect signify that higher foreign exchange rate volatility corresponds to greater uncertainty in the market, leading investors to demand higher returns for holding stocks, thus contributing to the observed impact on stock price volatility. In addition, increase in foreign exchange rates imply that foreign investors may seek
other investment opportunities and withdraw their stocks, which negatively affects liquidity and consequently stock price volatility in the stock market. Several studies are in tandem with this study finding. For instance, Atanasor & Nitschka (2017) revealed adverse effects of changing and fluctuating exchange rates on stock prices, particularly in Thailand and Japan. This aligns with the finding that foreign exchange rates have a negative effect on stock price volatility. In Kenya, Ongonga (2017) found that exchange rate variations significantly affected stock price levels for companies listed on the Nairobi Securities Exchange. Sakwa (2016) provided a theoretical framework and argued that the local currency appreciates against major currencies, exports become more expensive, potentially leading to decreased competitiveness and lower profits for export-oriented firms, causing price shocks in stock markets. Overall, these studies point that increase in foreign exchange rates has detrimental effects on stock price volatility.

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion of the Study
5.1.1 Effect of Inflation on Stock Price Volatility
Basing on the study findings, the empirical evidence demonstrated that inflation, while bearing a negative influence on the stock price volatility of the NSE 20 share index, holds no statistically significant effect. This nuanced outcome underscores the complexity of the interactions at play within Kenya’s stock market, suggesting the absence of a straightforward linear connection between inflation and stock price volatility. This, in turn, opens avenues for the consideration of alternative relationships, including potentially non-linear dynamics, which warrant further exploration.

5.1.2 Effect of Interest Rates on Stock Price Volatility
Basing on the empirical findings, the study concludes that while the observed effect of interest rate on stock price volatility in Kenyan stock market was negative, it was statistically insignificant and of minor magnitude. This conclusion hint at the possibility of alternative relationships between interest rates and stock price volatility, potentially involving non-linear quadratic dynamics. This conclusion underscores the complex dynamics that collectively steer stock price volatility. The muted influence of interest rates on stock price volatility within the Kenyan stock market context can be attributed to this intricate interweaving of multifaceted forces, highlighting the necessity of a holistic understanding when interpreting market behavior.

5.1.3 Effect of Foreign Exchange Rate on Stock Price Volatility
Basing on the findings, the study concludes that foreign exchange rates wield a negative and significant influence on stock price volatility in this market. The study concludes that increase in foreign exchange rates could potentially prompt foreign investors to seek alternative investment avenues, potentially leading to a withdrawal of investments. This domino effect adversely affects market liquidity and subsequently contributes to the decline in stock price volatility. This conclusion also supports the tenets of the Arbitrage Pricing Theory (APT), a framework positing that asset prices are inherently shaped by an array of macroeconomic factors, contributing collectively to the risk and return profile of a portfolio.

5.2 Recommendations of the Study
5.2.1 Recommendation to Practice
Market participants, policymakers, and investors should acknowledge the limitations of using interest rate fluctuations as the sole predictor of stock price volatility. The study emphasizes the importance of considering a diverse range of factors, including market sentiment and broader
economic conditions, when making investment decisions. This recognition can lead to more robust risk management strategies. In addition, Various market participants, such as market makers, hedge firms, investors, and traders, should adopt a diversified approach to their strategies. This diversified approach can enhance decision-making processes.

5.2.2 Recommendation to Policy
Given the significant impact of foreign exchange rates on stock price volatility, it is recommended that the government takes proactive measures to manage exchange rate fluctuations and mitigate their effects on the stock market. This may include implementing policies aimed at promoting exchange rate stability, such as prudent fiscal and monetary policies, intervention in the foreign exchange market when necessary, and enhancing transparency and communication regarding exchange rate policies. Additionally, the government should prioritize efforts to strengthen the economy and attract foreign investment, as a robust economy can help reduce vulnerability to external shocks and stabilize exchange rates. By addressing exchange rate volatility, the government can contribute to fostering a more stable and resilient stock market, thereby promoting investor confidence and supporting long-term economic growth.

5.3 Suggestions for Further Research
Based on the findings and methodology of this study, several avenues for further research can be explored to expand our understanding of the relationship between macroeconomic indicators and stock price volatility. First, while this study covered data from January 2009 to December 2021, examining a longer time period could provide deeper insights into the dynamic interplay between macroeconomic indicators and stock price volatility. A study spanning multiple economic cycles might uncover trends and patterns that are not apparent within the selected timeframe.

Second, future researchers could extend the research to include cross-country comparisons could enhance the understanding of the impact of macroeconomic indicators on stock price volatility. Comparing the findings with other emerging markets or even developed economies would provide a broader perspective on the observed relationships.

Third, while this study employed time series regression analysis and Error Correction Model, future researchers can utilize other econometric methods such as panel data analysis or machine learning techniques to offer alternative perspectives on the relationships between macroeconomic indicators and stock price volatility.

Fourth, future researchers could explore the role of investor behavior, sentiment, and psychological factors in influencing stock price volatility and contribute to a comprehensive understanding of market dynamics beyond the macroeconomic variables considered in this study.

Finally, future researchers should consider the potential non-linear relationships between macroeconomic indicators and stock price volatility, and employing nonlinear regression techniques, could reveal complex interactions not captured by linear models.

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