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# Macroeconomic Drivers of Exchange Rate Volatility: Evidence from Kenya

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## Abstract

This study examined the macroeconomic determinants of exchange rate volatility based on evidence from Kenya from 1971 to 2024. The study employed Autoregressive Distributed Lag (ARDL) bounds testing for co-integration and estimated the error correction model. Furthermore, ARCH and GARCH models were analyzed to measure the volatility of a time series by fitting an autoregressive model to the squared residuals of the time series. The ARCH and GARCH results suggest the volatility of the exchange rate markets in Kenya is not random. The speed of adjustment of the volatility in the Kenyan economy's exchange rate is 59.7%. The study found that in the long run, a unit increase in foreign direct investment (FDI) and government expenditure reduced exchange rate volatility by 36.4% and 341.5%, respectively, while inflation and money supply increased by 55.2% and 239.7%, respectively. Short-run results showed that a 1% increase in FDI, money supply and inflation rate increased volatility by 18.31%, 19.26%, and 111.83%, respectively, while government spending and public debt reduced volatility by 90.65% and 42.18%, respectively. To reduce or stabilise exchange rate volatility, the study recommended a combination of monetary policy interventions to policymakers. These included foreign exchange operations, interest rate adjustments, hedging strategies, and export diversification. Additionally, the central bank is advised to regulate the growth of the money supply to prevent excessive inflation and currency depreciation, which could exacerbate exchange rate fluctuations.

**Keywords:** *Exchange rate volatility, macroeconomic factors, GARCH, ARDL, JEL*

### 1.0 Introduction

Exchange rate volatility remains a persistent challenge in sub-Saharan Africa, affecting trade, inflation, and overall economic stability. Many African economies operate under different exchange rate regimes, ranging from floating to fixed and managed systems(Abban, 2020). However, irrespective of the regime, fluctuations in currency values are common, impacting economic performance. In Africa, exchange rate systems and policies are of particular importance due to the continent's diverse economic structures, external economic shocks, and varying dependence on global commodities(Dafe *et al.*, 2023). Exchange rates in Africa have shown considerable volatility over the past decade, influenced by both domestic and global factors. The exchange rates of African currencies are often shaped by the type of exchange rate regime adopted by individual countries, whether fixed, pegged, or floating and the macroeconomic conditions within those countries (Mimouni, 2016). Countries like Lesotho and Eritrea maintain fixed exchange rate regimes, where the value of their currencies is closely aligned with that of other stronger currencies(Abban, 2020).

Kenya has experienced significant exchange rate volatility over the past two decades, impacting business operations, trade, and economic planning. As shown in Figure 1, exchange rate volatility in Kenya has exhibited significant fluctuations over the years. From 1971 to the early 1980s, the exchange rate remained relatively stable, with minimal volatility. However, the late 1970s and early 1980s saw a sharp rise in volatility, reaching a peak of 86.7% around 1980. This period was marked by global economic shocks, structural adjustments, and changes in Kenya's foreign exchange policies. In the 1990s, the country experienced another wave of volatility, with fluctuations reaching around 81.9% in 2000. The liberalization of the foreign exchange market and economic reforms played a role in these variations. By the mid-2000s, volatility had started to decline, though occasional spikes were observed due to external shocks and inflationary pressures. The 2010s saw a relatively more stable exchange rate environment, with volatility fluctuating between 9.9% and 16.5%. However, more recent years, including the post-pandemic period, have shown moderate fluctuations, with exchange rate volatility remaining around 9.7% in 2020 and slightly reducing by 2023. Persistent fluctuations in exchange rates affect economic stability and investment attractiveness in an economy (Aidoo, 2017; Otieno, 2022).

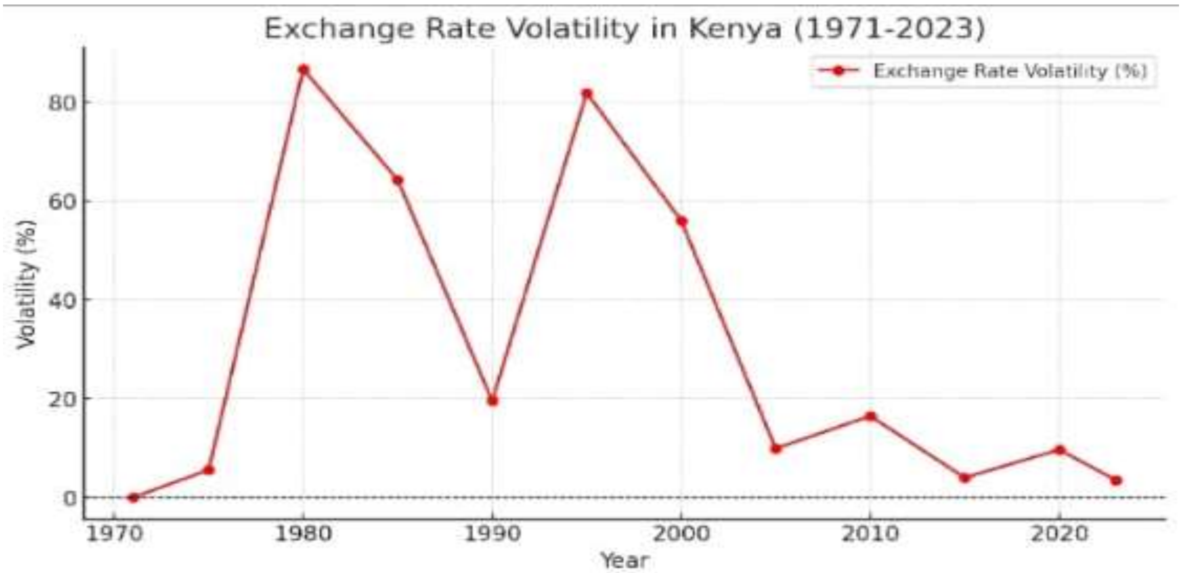


**Figure 1:Exchange Rates Volatility in Kenya (1971 -2024)**

**Source**: *Authors' calculation using E-views 12*

The exchange rate is among the key tools of the economy used to correct numerous economic misalignments a country may be facing. Volatility in exchange rates has pervasive effects on prices, wages, production levels, and employment opportunities(Obstfeld & Rogoff, 2021). Volatility in the value of currencies of different economies has increased after the collapse of the economy (Cooper, 2019). Despite Kenya's growing economy and increasing integration into the global market, the fluctuation of the Kenyan exchange rate remains a concern for economic stability and investment attractiveness. In the recent past, the Kenyan shilling has experienced a rapid depreciation due to volatility in foreign exchange rates against major currencies like the United States (US) dollar. The Kenyan shilling depreciated by an average of 0.6 per cent per month against the United States (US) dollar in 2022. This trend continued in early 2023, with average monthly depreciation rates reaching around 4% and, in some months, experiencing an increase of up to 6%. This sharp depreciation in the Kenyan shilling (KES) and its volatility raise concerns about the effect of currency volatility and its impact on the Kenyan economy. According to empirical studies, exchange rate fluctuations result from the combined effects of monetary factors, fiscal policy, and macroeconomic conditions (Galí & Monacelli, 2016). Therefore, this study investigates the underlying effects of selected macroeconomic variables on exchange rate volatility in Kenya. The research aims to examine how FDI, interest rate, inflation rate, government expenditure and public debt affect exchange rate volatility in Kenya.

## 2.0Literature Review

General equilibrium theory offers a comprehensive framework for analysing how fiscal and monetary variables interact and influence exchange rate volatility. The theory maintains that economic markets adjust simultaneously to achieve a state of equilibrium, where all markets, including money, goods, and foreign exchange, are interconnected (Acemoglu & Robinson, 2019). Exchange rate fluctuations result from the combined effects of monetary factors, fiscal policy, and macroeconomic conditions (Galí & Monacelli, 2016). It suggests that fiscal and monetary variables jointly affect currency value(Alfaro, Bloom, & Lin, 2024). Fiscal expansion can cause inflationary pressures and interest rate shifts, which then influence capital flows and exchange rate stability. Monetary policy aimed at controlling inflation or encouraging growth influences exchange rate behaviour through liquidity adjustments and investor expectations (Cecioni, Ferrero, & Secchi, 2019). This theoretical perspective provides a structured approach to analysing the effects of macroeconomic policies on exchange rate volatility, making it relevant for examining the interaction between fiscal and monetary variables within an open economy.

The theory of purchasing power parity was introduced by the Swedish economist Gustav Cassel in 1918. This theory was a basis for recommending a new set of official exchange rates at the end of World War I. Cassel used this theory to allow for the resumption of normal trade relations(Kirai, 2018). Purchasing power parity (PPP) is a measure of the price of specific goods in different countries and is used to compare the absolute purchasing power of the countries' currencies.PPP states that exchange-adjustments should lead to a similar price for the same good worldwide, that is, a unit of the home currency should have the same purchasing power around the world. The theory bases its prediction of exchange rate movements on the changing patterns of trade due to different inflation rates between countries. Therefore, when inflation in one nation exceeds that of its trading partner, the exchange rate adjusts by weakening the high-inflation country's currency to maintain equivalent purchasing capacity.

In empirical studies, the relationship between interest rates and exchange rates is well-established in the literature. Studies suggest that higher interest rates generally lead to currency appreciation due to increased foreign investments, as observed by Ndung'u (2000) and Kiptoo (2007). However, restrictive policies such as interest rate caps may increase volatility and deter foreign investors. Global studies, such as Patra (2004), emphasize the varying correlations between interest rate differentials and exchange rates over time and across economies. The impact of inflation on exchange rates is similarly well-documented. Research indicates a strong negative relationship between inflation and exchange rates, with higher inflation leading to currency depreciation (Mutuku, 2013; Kaboro, 2019). However, Oranga (2022) finds a positive correlation, attributing it to external economic factors. Inflation also weakens monetary policy effectiveness in controlling exchange rate volatility.

Research on FDI and exchange rates reveals that FDI inflows typically lead to currency appreciation by increasing demand for local assets and foreign reserves in Kenya (Mabwa, 2024). Studies find that FDI inflows often lead to currency appreciation due to increased demand for local currency (Kiyota & Urata, 2004). However, Mwega and Ngugi (2006) caution that repatriation of profits can later exert downward pressure on exchange rates. The impact of public debt on exchange rates is largely negative. High public debt is associated with currency depreciation due to increased risk perception (Bénétrix *et al*., 2019; Dell'Ariccia *et al.,* 2018). Studies in Kenya (Odera, 2015; Njenga, 2022) confirm that external debt servicing increases exchange rate volatility.

Similarly, excessive government expenditures have been linked to short-term currency appreciation but long-term depreciation due to fiscal deficits. Expansionary fiscal policies initially cause currency appreciation but may lead to depreciation if they result in unsustainable deficits (Corsetti & Müller, 2015; Bouakez & Eyquem, 2015). The impact of the Money Supply and Exchange Rate is typically negative. An increase in money supply is generally linked to currency depreciation (Chen & Liu, 2018; Fratzscher & Rieth, 2019). However, Kibiy and Nasieku (2016) suggest it may also reduce exchange rate volatility.

## 3.0 Methodology

*Data Issues*

In this study, macroeconomic factors and exchange rate volatility variables that were used were for the 1971-2024 period in Kenya. The dependent variable data, exchange rate, was sourced from the World Bank Database. Secondary data for independent variables such as government expenditures and Inflation were obtained from the Kenya National Bureau of Statistics (KNBS). Data on FDI were taken from the World Bank Database. Public debt data was extracted from the National Treasury. Data on money supply and interest rates were obtained from the Central Bank of Kenya.

*ARDL Model Specification*

This study utilized the Autoregressive Distributed Lag (ARDL) model developed by Pesaran et al. (2001) to analyze the dynamic relationship between exchange rate volatility (ERV) and selected macroeconomic variables. The advantage of using the ARDL approach is that it employs only a single reduced equation. The ARDL model is suitable for time-series data, particularly when the variables exhibit different orders of integration (I(0), I(1), or a mixture of both). According to Pesaran et al. (2001), the ARDL model eliminates the need for pre-testing the order of integration, allowing the examination of long-run relationships among variables, whether they are I(0), I(1), or a combination of both. The ARDL model allows for the separation of both short-run and long-run effects, making it highly relevant for analyzing relationships between variables over different time horizons. In its equilibrium correction (EC) representation, the ARDL model provides a means to test for cointegration, which is crucial for determining whether a long-run relationship exists among the variables of interest. This was particularly important for this study, as it helped in the determination of how exchange rate volatility was influenced by the macroeconomic factors under consideration.Therefore, the relationship between exchange rate volatility and macroeconomic variables was expressed in a general functional form of the ARDL model as shown in Equation 1.

$$ERV_t = f(FDI_{\{t\}}, GE_{\{t\}}, PD_{\{t\},} INTR_{\{t\}}, INFL_{\{t\}}, MS_{\{t\}}) \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots \quad (1)$$

Where;

$ERV$ represents the exchange rate volatility at time t, as a function of (f)

$FDI$ represents foreign direct investment at time t,

$GE$ represents government expenditure at time t,

$PD$ represents public debt at time t, and

$INTR$ represents the interest rate at time t.

$INFL$ represents the inflation rate at time t,

$MS$ represents the money supply at time t,

To facilitate the empirical estimation of the ARDL model, the general functional form presented in Equation 1 was re-specified in a linear econometric framework, as shown in Equation 2, and adapted from Pesaran, Shin, and Smith (2001) as follows:

$$ERV_t = \alpha_0 + \beta_1 FDI_{\{t\}} + \beta_2 GE_{\{t\}} + \beta_3 PD_{\{t\}} + \beta_4 INTR_{\{t\}} + \beta_5 INFL_{\{t\}} + \beta_6 MS_{\{t\}} + \epsilon_t \ldots\ldots (2)$$

Where:

$\alpha_0$is the intercept (constant),

$\beta_1, \beta_2, \beta_3$ represent the coefficients of the independent variables.

$\epsilon_t$is the error term that captures the unobserved explanatory elements

However, exchange rates and macroeconomic variables often exhibit dynamic behaviour, where past values influence present outcomes. To adequately capture this dynamic nature and the presence of volatility clustering in exchange rate movements, this study employed the Generalised Autoregressive Conditional Heteroskedasticity (GARCH) model, specifically the GARCH(1,1) specification, due to its effectiveness in modelling time-varying variance through past squared residuals and lagged conditional variances(Bollerslev, 1986; Engel, 1982). Before applying the Generalized Autoregressive Conditional Heteroskedasticity model, an Autoregressive Conditional HeteroskedasticityLagrange Multiplier (ARCH-LM) test was performed to detect heteroskedasticity, thus justifying the use of GARCH-type models. The real effective exchange rate was transformed into its logarithmic form and analyzed via a moving average process, with the conditional variance obtained from the model serving as a proxy for exchange rate volatility(Chen *et al*., 2022).

Subsequent to volatility estimation, stationarity tests, including the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests, were conducted on all variables to determine their integration orders and to confirm that none were integrated of order two, which would compromise the validity of the autoregressive distributed lag (ARDL) framework. Following confirmation of integration orders, the optimal lag length for the ARDL model was determined based on the Akaike Information Criterion (AIC), which balanced model fit and ensured simplicity to avoid overfitting. The bounds testing approach developed by Pesaran et al. (2001) was employed to test for the presence of a long-run relationship among the variables. Subsequently, the long-run coefficients were estimated, and the model was reparameterized following Equation 3 to formulate the dynamic Error Correction Model (ECM) as described by Hassler and Wolters (2006). This step involved estimating both the Error Correction Term (ECT) and the short-run coefficients. The ECT indicates the speed at which the system returns to equilibrium after experiencing short-term deviations. The general ARDL model for this study is as specified in Equation 3.

$ERV_t = \alpha_0 + \Sigma_{\{i=1\}}^{\{p\}} \beta_i EXV_{\{t-i\}} + \Sigma_{\{j=0\}}^{\{q_1\}} \delta_{\{1j\}} FDI_{\{t-j\}} + \Sigma_{\{j=0\}}^{\{q_2\}} \delta_{\{2j\}} \text{GE}_{\{t-j\}} +$

$+ \Sigma_{\{j=0\}}^{\{q3\}} \delta_{\{3j\}} PD_{\{t-j\}} + \Sigma_{\{j=0\}}^{\{q_4\}} \delta_{\{4j\}} INTR_{\{t-j\}} + \Sigma_{\{j=0\}}^{\{q_5\}} \delta_{\{5j\}} INFL_{\{t-j\}} +$

$\Sigma_{\{j=0\}}^{\{q_6\}} \delta_{\{6j\}} \text{MS}_{\{t-j\}} + \theta_1 FDI_t + \theta_2 \text{GE}_t + \theta_3 \text{PD}_t + \theta_4 INTR_t + \theta_5 INFL_t +$

$\theta_6 \text{MS}_t + \epsilon_t$……………………………………………………………………………….. (3)

Where;

$t - j$; lagged values of money supply.

$\alpha_0$: Intercept.

$\beta_i \ \delta_{\{ij\}}$: Short-run coefficients.

$\theta_1 \theta_2 \theta_3 \theta_4 \theta_5 \theta_6$: Long-run coefficients.

$\boldsymbol{\epsilon_t}$: the error term is assumed to be normally distributed with a mean of zero and constant variance of sigma squared, $e \sim N\ (0, \sigma^2)$, and was included in the model to account for other factors that were not included in the model but affected the exchange rate volatility.

To ensure the accuracy, reliability, and validity of the multivariate regression model estimated using the Autoregressive Distributed Lag (ARDL) framework, several essential post-estimation diagnostic tests were conducted. These tests assessed the key assumptions underlying the classical linear regression model and evaluated the overall adequacy and robustness of the estimated model. The diagnostic tests that were conducted included the Breusch-Godfrey LM test for detecting serial correlation, the Breusch-Pagan-Godfrey test for identifying heteroskedasticity, and the Jarque-Bera test for assessing the normality of residuals.

## 4.0Findings and Discussion

### 4.1Measuring Volatility of Kenya's Exchange Rate

The study applied the ARCH-LM test to assess the volatility of Kenya's exchange rate, with results significant at the 5% level, as shown in Table 1 below.

**Table 1: Results of ARCH-LM Effect Test**

| **Heteroskedasticity Test: ARCH** | | | |
|---|---|---|---|
| F-statistic | 107.2168 | Probability | 0.0000 |
| Obs*R-squared | 42.3277 | Probability | 0.0000 |

**Source**: *Authors' calculation using E-views 12*

Table 1 shows the results of the ARCH Lagrange Multiplier (ARCH-LM) test applied to Kenya's exchange rate volatility. The test produced a p-value of 0.00, which is well below the 0.05 significance level. Consequently, the null hypothesis of no ARCH effects is rejected, indicating the presence of ARCH effects in the exchange rate series during the sample period.

The F-statistic value of 107.2168 demonstrates that the lagged squared residuals are jointly statistically significant in explaining the current squared residuals, thereby confirming the existence of conditional heteroskedasticity in the data. Additionally, the Observed $R$-squared statistic, which equals 42.3277, is calculated based on the sample size and the goodness of fit of the auxiliary regression. This test statistic is compared against a chi-square distribution with degrees of freedom corresponding to the number of lags included in the model. Given the $p$-value of 0.00, the test provides strong evidence supporting the presence of ARCH effects. These findings confirm that exchange rate volatility in Kenya exhibits significant volatility clustering, characterized by periods of high volatility being followed by similarly volatile periods, and periods of low volatility being followed by low volatility. This evidence justifies the application of time-varying volatility models, such as ARCH or GARCH, in the analysis of Kenya's exchange rate dynamics.

The calculated coefficients for Kenya's exchange rate volatility were presented in Table 2 of the results, which show how well the GARCH variance series, which was obtained from the GARCH (1, 1) model, represents real exchange rate volatility. Table 2 results present the estimated coefficient from the GARCH (1, 1) model, which was used to model the volatility of Kenya's exchange rate.

**Table 2: GARCH Model Coefficients**

| Test | Coefficient | Standard error | z-value | p-value |
|---|---|---|---|---|
| GARCH (1,1) | 0.8909 | 0.0148 | 60.1542 | 0.0000 |

Source: Authors' calculations.

The GARCH term had a coefficient of 0.8909 with a standard error of 0.0148. The resulting *z*-value was 60.1542, and the *p*-value was 0.0000, indicating that the coefficient was statistically significant at the 1% level. The estimated GARCH coefficient of 0.8909, which was close to one, suggests that volatility shocks tend to persist over time. This implied that a large movement in the exchange rate in one period was likely to be followed by continued high volatility in subsequent periods. Such behaviour was indicative of volatility clustering. The results indicate that past volatility has a strong and statistically significant effect on current exchange rate volatility in Kenya.

### 4.2 Testing for Stationarity

For robust ARDL estimation results, the study first tested for stationarity, aided by the Augmented Dickey-Fuller (ADF) and Philips Peron (PP) unit root tests.

**Table 3: Results of ADF and PP unit root tests**

| Variables | Level | | First difference | | Order of integration |
|---|---|---|---|---|---|
| | ADF t-Statistics | PP t-Statistics | ADF t-Statistics | PP t-Statistics | |
| ERV | -1.0557 | -1.0249 | -5.7133 | -5.7133 | I(1) |
| FDI | -6.6499 | -6.8177 | - | | I(0) |
| GE | -0.8659 | -0.8870 | -7.0681 | -7.0816 | I(1) |
| PD | -2.3903 | -2.5646 | -6.5292 | -6.5426 | I(1) |
| INTR | -1.6976 | -1.4518 | -6.2236 | -7.7845 | I(1) |
| INFL | -5.2036 | -5.2286 | - | | I(0) |
| MS | -1.7040 | -1.5955 | -8.3437 | -8.6889 | I(1) |

**Source**: *Authors' calculation using E-views 12*

The Augmented Dickey-Fuller (ADF) and Philips Peron (PP) unit root tests were conducted to examine the stationarity properties of the study variables. The test evaluated the null hypothesis that each variable contains a unit root against the alternative hypothesis of stationarity. The results, as shown in Table 3, indicated that at their level form, exchange rate volatility, government expenditure, public debt, interest rate, and money supply failed to reject the null hypothesis, with p-values above 0.05. This indicates that these variables contain a unit root at the level. However, foreign direct investment and inflation rate rejected the null hypothesis at level with *p*-values less than 0.05, implying these variables are stationary. After first differencing, exchange rate volatility, government expenditure, public debt, interest rate, and money supply were rejected of the null hypothesis with *p*-values of 0.0000, confirming stationarity. The PP test results align with the ADF test outcomes, confirming that most variables are integrated of order one, I(1), while FDI and INFL are integrated of order zero, I(0).

**4.3Selection of model with optimum lags**

To conduct the ARDL analysis for the study, the appropriate lag length for the Vector Auto regression (VAR) model was determined as shown in Table 4 of the results.

**Table 4: Lag Length Selection Results**

| Lag | Log L | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | 135.7016 | NA | 1.85e-12 | -7.1501 | -6.8422 | -7.0426 |
| 1 | 315.8643 | 280.2530 | 1.34e-15 | -14.4369 | -11.9737* | -13.5772 |
| 2 | 383.5176 | 78.9288* | 6.56e-16* | -15.4732* | -10.8546 | -13.8612* |

Legend: * indicates lag order selected by the criterion

**Source***: Authors' calculation using E-views 12*

As shown in Table 4, the optimal lag length was determined based on multiple selection criteria, including the Akaike Information Criterion (AIC), Final Prediction Error (FPE), Schwarz Information Criterion (SC), Hannan–Quinn (HQ) criterion, and the Likelihood Ratio (LR) test. The lag length of 2 yielded the lowest AIC value (–15.47), the lowest FPE (6.56e–16), and was also supported by the HQ and LR criteria, confirming it as the most suitable lag for the model. The AIC is particularly preferred in model selection as it reduces the likelihood of underestimating lag length and is generally more reliable than the sequential LR test (Liew, 2004). It also incorporates aspects of model fit and complexity. Although the SC suggested lag 1, the majority of the criteria support lag 2. Based on these results, the optimal model selected for ARDL estimation is ARD(1, 1, 0, 0, 2, 0, 0), which appeared among the top two models with the lowest AIC values. Therefore, this ARDL specification was adopted for the subsequent cointegration test analysis.

**4.4 Estimation of the F-Bound Test for the ARDL Cointegration Model**

After assessing stationarity and the levels of integration, the autoregressive distributed lag bounds test for integration was performed as shown in Table 5.

**Table 5:Bounds Test Result**

| Test Statistics | Value | Significance | Level | |
|---|---|---|---|---|
| *F-Statistics* | 8.72** | | I(0) | I(1) |
| *K* | | 10% | 1.75 | 2.87 |
| | | 5% | 2.04 | 3.24 |
| | | 1% | 2.66 | 4.05 |

Legend: **Significant at 5% level. Critical values are based on Narayan (2005) for small sample sizes.

**Source**: *Authors' calculation using E-views 12*

As shown in Table 5, the calculated *F*-statistic of 8.72 exceeds the upper critical bound values at the 5%significance level. This leads to the rejection of the null hypothesis of no long-run relationship among the variables. Therefore, the results provide strong evidence of a co-integrating relationship, indicating that the variables move together in the long run.

**4.5 Model Estimation Results**

The study estimated both long-run and short-run relationships among the variables using the ARDL model. The analysis included an examination of the long-run coefficients and short-run dynamics, with particular attention to the adjustment process captured through the error correction mechanism.

**4.5.1 ARDL Long-run Estimation**

Table 6 of the results shows the long-form run results for a long-run relationship between the independent variables (FDI, GE, PD, INFL, INTR and MS) and the dependent variable (ERV).

**Table 6:Coefficient of long-run relationship in the ARDL Model**

| Variable | Coefficient | Standard Error | t-Statistics | P-Value |
|---|---|---|---|---|
| FDI | -0.3637 | 0.14613 | -2.4887 | 0.0196** |
| INTR | 0.2632 | 0.2309 | 1.1396 | 0.2648 |
| INFL | 0.5524 | 0.1517 | 3.6423 | 0.0012** |
| MS | 2.3972 | 0.3913 | 6.1261 | 0.0000** |
| GE | -3.4153 | 0.4293 | -7.9560 | 0.0000** |
| PD | -0.1445 | 0.3208 | -0.4504 | 0.6562 |
| CONS | 1.1468 | 0.2828 | 4.0542 | 0.0010** |
| | | R-Squared=0.7379 | Durbin Watson | 2.5261 |

Legend:**Significant at 5% level

**Source**: *Authors' calculation using E-views 12*

As shown in Table 6, FDI exhibited a significant negative relationship with exchange rate volatility, with a coefficient of -0.3637 ($p$ = 0.0196). This indicated that a 1% increase in net inflows of FDI as a percentage of GDP leads to a 36.4% reduction in exchange rate volatility in the long run, holding other factors constant. This finding aligns with prior studies by Kiyota and Urata (2004) and Amondi (2016), which also documented that FDI stabilises exchange rates by increasing capital availability and productivity. The mechanism behind this relationship can be attributed to the role of FDI in enhancing macroeconomic stability by improving the balance of payments position and increasing demand for the domestic currency. Kiyota and Urata (2004) found that in emerging markets, FDI inflows led to exchange rate appreciation through strengthened capital accounts, while Amondi (2016) observed that FDI in Kenya's real estate and energy sectors increased investor confidence and shilling demand. Theoretically, this outcome is underpinned by the Interest Rate Parity (IRP) and general equilibrium frameworks, which suggest that capital inflows such as FDI influence currency value through investment-related demand shifts and inter-market adjustments. Increased FDI enhances reserves, reduces reliance on volatile short-term capital, and signals long-term confidence in the economy, thereby mitigating speculative currency pressures and lowering volatility in the foreign exchange market.

Inflation rate was positively and significantly associated with exchange rate volatility, with a coefficient of 0.5524 ($p$ = 0.0012). This suggests that higher inflation exacerbates currency fluctuations, possibly due to eroding purchasing power and heightened uncertainty, consistent with earlier findings from Popa and Codreanu(2010) and Yensu et al. (2022). Inflation (INFL), with a coefficient of 0.5524, reveals a strong and significant positive impact on exchange rate volatility. This suggests that rising inflation erodes investor confidence and the purchasing power of the domestic currency, causing it to fluctuate more frequently. The result aligns with Ndung'u (1997) and Mutuku (2013), who documented that inflation led to depreciation of the Kenyan shilling, especially during periods of global oil price surges. The Purchasing Power Parity (PPP) theory provides a theoretical foundation for this relationship by explaining that inflation differentials between countries induce exchange rate adjustments as markets seek to restore parity in purchasing power. Consequently, high inflation creates uncertainty and volatility in the foreign exchange market by affecting both demand for the currency and speculative behaviour among investors.

Money supply had the strongest positive effect on exchange rate volatility, with a coefficient of 2.3972 ($p < 0.001$), implying that rapid growth in the money supply significantly increases exchange rate instability. Money Supply (MS), with the highest coefficient at 2.3972, demonstrates that excessive liquidity significantly amplifies exchange rate volatility. This occurs because an increased money supply without corresponding growth in economic output generates inflationary pressures and fuels speculative activities in the foreign exchange market. These speculative movements create fluctuations in currency value and reduce exchange rate stability. This finding aligns with empirical studies by Chen and Liu (2018) and Fratzscher and Rieth (2019), who reported similar dynamics in China and the European Union, respectively. The General Equilibrium Theory supports this relationship by emphasizing how monetary expansion can disrupt equilibrium across interconnected financial and goods markets, leading to increased volatility in exchange rates.

Government expenditure exhibited a significant negative coefficient of -3.4153 ($p < 0.001$), indicating that increased government spending contributes to stabilizing the exchange rate in the long run. Government Expenditure (GE), with this strong negative effect, suggests that higher public spending enhances investor confidence and stimulates economic demand, which in turn supports exchange rate stability. This finding aligns with the works of Corsetti and Müller (2015) and Popa and Codreanu(2010), who highlighted that moderate and productive government expenditure improves macroeconomic stability and reduces currency volatility. Theoretically, the General Equilibrium Theory explains that efficient fiscal expansion reduces economic uncertainty and positively shapes market expectations, thereby dampening exchange

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rate fluctuations. Enhanced government spending may boost economic output and liquidity in ways that stabilize foreign exchange markets over the long term.

### 4.5.2 ARDL Short-Run Estimation

The second step was the estimation of the short-run coefficients. Table 7 presents the short-run results generated from the ARDL regression model.

**Table 7: Coefficient of short-run relationship in the ARDL model**

| Variable | Coefficient | Standard Error | t-Statistics | P-Value |
|---|---|---|---|---|
| ΔFDI | 0.1831 | 0.0229 | 7.9666 | 0.0041** |
| ΔINTR | 0.0742 | 0.0291 | 2.5492 | 0.0840 |
| ΔINFL | 0.1926 | 0.0245 | 7.8595 | 0.0043** |
| ΔMS | 1.1183 | 0.2066 | 5.4132 | 0.0124** |
| ΔGE | -0.9065 | 0.2351 | -3.8568 | 0.0308** |
| ΔPD | -0.4218 | 0.0538 | -7.8282 | 0.0043** |
| CONS | 1.1468 | 0.2828 | 4.0542 | 0.0010** |
| ECT | -0.5975 | 0.0597 | -10.0138 | 0.0021** |
| | | R-Squared=0.9610 | Durbin Watson | 2.0719 |

Legend: **Significant at 5% level

**Source**: *Authors' calculation using E-views 12*

Table 7 of the results revealed that foreign direct investment (FDI) had a positive and statistically significant effect on exchange rate volatility in the short run at the 1% significance level. The coefficient of 0.1831 suggests that a 1% increase in net inflows of FDI as a percentage of GDP would lead to an 18.31% increase in exchange rate volatility in Kenya, holding other variables constant. The p-value of 0.0041 is less than 0.01, leading to rejection of the null hypothesis. This implies that FDI tends to increase short-term exchange rate volatility, likely due to the destabilizing effect of short-term capital inflows and speculative movements. This result aligns with Kiyota and Urata (2004), who found that FDI inflows appreciate the currency by increasing demand for the local currency. The result is also consistent with the portfolio balance theory, which posits that capital inflows can affect exchange rates by altering the supply and demand for domestic and foreign assets. Additionally, Mwega and Ngugi (2006) emphasized that while FDI may strengthen the currency, repatriation of profits and volatile capital flows can cause short-term exchange rate fluctuations. Similarly, Ochieng (2018) and Amondi (2016) observed that rapid capital movements linked to FDI inflows increase short-run exchange rate volatility despite potential long-term stabilization.

The inflation rate (INFL) had a positive and statistically significant effect on exchange rate volatility at the 1% level, with a coefficient of 0.1926. This indicates that a 1% increase in inflation leads to a 19.26% increase in exchange rate volatility, ceteris paribus. This finding aligns with Kiyota and Urata (2004), who noted that inflationary pressures reduce the purchasing power of the currency, increasing demand for foreign currency and causing exchange rate fluctuations. The result is consistent with the monetary approach to exchange rate determination, which links inflation differentials to exchange rate movements through relative purchasing power parity. Rising inflation increases uncertainty and speculative pressures, thereby amplifying short-term exchange rate volatility.

Money supply (MS) exhibited a positive and statistically significant effect on exchange rate volatility at the 5% level. The coefficient of 1.1183 implies that a 1% increase in money supply causes a substantial 111.83% increase in exchange rate volatility. This finding supports the monetary model theory, which suggests that an expansionary monetary policy increases liquidity, triggers inflationary expectations, and pressures the exchange rate. It also corroborates empirical studies such as Chen and Liu (2018), who reported that increases in money supply lead to currency depreciation and volatility, and Fratzscher and Rieth (2019), who linked non-sterilised monetary interventions to exchange rate fluctuations.

Government expenditure (GE) had a negative and statistically significant effect on exchange rate volatility at the 5% level, with a coefficient of –0.9065. This suggests that a 1% increase in government spending reduces exchange rate volatility by 90.65%, holding other factors constant. This result aligns with the Keynesian theory that fiscal stimulus through government expenditure can stabilize aggregate demand and improve investor confidence, thus reducing exchange rate fluctuations. The finding is supported by Corsetti and Müller (2015), who observed that fiscal expansions can stabilize exchange rates, and Li and Zhu (2024), who noted the role of government spending in exchange rate stability under flexible regimes.

Public debt (PD) also had a negative and statistically significant effect on exchange rate volatility, with a coefficient of –0.4218 at the 1% level. This indicates that a 1% increase in public debt reduces exchange rate volatility by 42.18%. This suggests that increased government borrowing, when effectively managed, may enhance macroeconomic stability by financing productive investments and stabilizing market expectations. The result is consistent with Morenike and Chukwuyem (2024), who found that public debt can reduce short-term exchange rate volatility in certain contexts, and Odera (2015), who linked sound public debt management to enhanced exchange rate stability. The finding can also be explained by the debt-stabilization hypothesis, which posits that prudent borrowing supports fiscal sustainability and exchange rate stability.

Interest rates (INTR) showed a positive but statistically insignificant effect on exchange rate volatility in the short run, with a coefficient of 0.0742 and p-value of 0.0840. This indicates that increases in interest rates tend to be associated with higher exchange rate variability, possibly due to monetary policy's influence on capital flows and foreign exchange markets, consistent with the uncovered interest rate parity theory. However, the weak significance suggests that other factors may dominate interest rate effects in the short run.

Table 7 results also indicated that the coefficient of determination ($R^2$) was high at 0.9610, implying that approximately 96.1% of the variation in exchange rate volatility in Kenya was explained by the independent variables in the short run. This high $R^2$ value suggests that the estimation model provided an excellent fit to the data and effectively captured the main factors influencing exchange rate volatility dynamics in Kenya.

**4.5.3 Robustness Tests**

It is important to conduct post-estimation diagnostic tests of normality, serial correlation, and heteroscedasticity to ensure the stability, reliability, and robustness of the model. Table 8 reports the diagnostic tests results.

**Table 8: Residual diagnostic tests**

| Test | F-Statistics (p-values) | Null Hypothesis |
|---|---|---|
| Heteroskedasticity Test: Breusch-Pagan-Godfrey | 2.6304 (0.0242) | No heteroscedasticity |
| Breusch-Godfrey Serial Correlation LM Test: | 2.1973 (0.1330) | No serial correlation |
| Jarque-Bera | 0.1397 (0.9325) | Residuals are normally distributed |

**Source**: *Authors' calculation using E-views 12*

The Breusch-Pagan-Godfrey test resulted in an F-statistic of 2.6304 and a p-value of 0.0242, leading to the rejection of the null hypothesis of homoskedasticity and indicating heteroskedasticity in the residuals. In contrast, the Breusch–Godfrey LM test indicated no autocorrelation, with an F-statistic of 2.1973 and a p-value of 0.1330, suggesting the model is correctly specified regarding serial correlation. As shown in Table 8, the Jarque–Bera normality test results yielded a p-value of 0.9325, which was well above the 5% significance level. This indicated that the null hypothesis of normally distributed residuals was not rejected. Consequently, the assumption of normally distributed residuals was met, supporting the reliability of hypothesis testing within the ARDL modelling framework.

## 5.0 Conclusion

The study aimed at measuring and analyzing the impact of macroeconomic variables on the exchange rate volatility of the Kenyan economy during the period 1971–2024. In order to test the stationarity of the variables of the study model, the augmented Dickey–Fuller and the Philips Perron tests were applied. The results showed that the variables were not stationary at their levels, but they became so when taking the first difference with the intercept.In this study, six indicators of macroeconomic are used, with the volatility data analysis method using Generalized Autoregressive Conditional Heteroscedasticity (GARCH), while the regression analysis applies Autoregressive Distributed Lag (ARDL).The ARCH-LM and GARCH(1,1) models confirmed the presence of volatility clustering, a common feature in exchange rate behaviour, indicating that periods of high volatility tend to be followed by further volatility. The long-run results of the ARDL model demonstrated that foreign direct investment (FDI) had a negative long-run effect on exchange rate volatility, suggesting that sustained inflows of FDI help to stabilize the exchange rate. Inflation exhibited a positive and significant long-run impact on exchange rate volatility. This finding indicates that rising inflation contributes to currency instability by undermining purchasing power and increasing market uncertainty. Money supply was found to have the most pronounced positive long-run effect on exchange rate volatility. Government expenditure had a significant negative effect on exchange rate volatility in the long run. Increased public spending, especially when directed towards productive investments, appears to support currency stability by fostering economic growth and enhancing investor confidence. The short-run model reveals that foreign direct investment (FDI), inflation, and money supply increase exchange rate volatility in Kenya, while government expenditure and public debt help reduce it. This highlights the need for stable inflation management, controlled money supply, and investment-friendly fiscal policies to stabilise the exchange rate.

**6.0 Recommendations**

The findings of this study present several important policy implications for the government of Kenya, particularly in promoting stable and long-term foreign direct investment (FDI) inflows. Streamlining investment procedures and enhancing infrastructural facilities are essential to attract more FDI, which can help stabilise the exchange rate through consistent forex inflows. Additionally, creating a stable investment climate, developing investor protection mechanisms, and offering tax incentives are crucial for encouraging FDI. Maintaining prudent fiscal policies is another key implication. Targeted government expenditure focused on productive sectors can reduce exchange rate volatility and enhance investor confidence. Moreover, controlling inflation is vital; the government should implement effective inflation-targeting frameworks through the Central Bank of Kenya (CBK) and respond swiftly to supply shocks. The study also highlights the need for monetary policy tightening, as an expanded money supply is linked to higher exchange rate volatility. Measures should be adopted to control M3 growth and align liquidity injections with national output levels. Increasing USD reserves to support the economy during inflationary periods and reducing activities that do not contribute to output are essential for stabilising the exchange rate. Lastly, improved coordination between fiscal and monetary authorities is necessary. Harmonizing policies between the Treasury and the CBK will minimize inconsistencies and volatility in economic management. Future research should expand the scope to include additional macroeconomic variables, such as economic growth and political stability, to provide more comprehensive insights into minimizing exchange rate volatility in Kenya and similar economies.

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