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# Foreign Exchange Rate Volatility and Its Effect on International Trade in Kenya

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**ABSTRACT**

**Exchange rate volatility has received much attention in economic research especially with the advent of floating exchange regimes. The volatile nature of exchange rate is generally perceived as having negative affect on international trade. However, the theoretical and empirical perspective are mixed on the nature of the relationship. This study aimed at examining analyzing the moderating effect of foreign exchange reserves on the relationship between foreign exchange rate volatility and international trade in Kenya. The study used error correction model in the analysis of the time series data for the study period which spanned between 1966-2018. Results show that controlling for inflation rate, interest rate and gross domestic product, foreign exchange reserves had a positive and statistically significant moderating effect at 5% significant level on the relationship between foreign exchange rate volatility and international trade with $R^2$ of 0.9557. The study recommends maintaining enough stock of foreign exchange reserves to cushion the economy from adverse effects of exchange rate volatility. The findings of the study will provide relevant information in the formulation of and implementation of an effective monetary policy that will promote exchange rate stability and improve the country's performance in international trade.**

**Keywords:** Exchange Rate Regimes, Exchange Rate Volatility, Foreign Exchange Reserves, and International Trade.

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## I. Introduction

International trade is the cross-border exchange of goods and services (Vernon, 2017). According to global strategic rivalry theory of international trade, Booth and Erskine (2016) argue that international trade exposes domestic firms to the higher standards practiced by foreign firms and this leads to increased efficiency. According to the traditional school of thought, there is a connection between international trade and exchange rate volatility. The theory postulates that volatility of exchange rate reduces trade to very low levels owing to the nature of traders. The theory asserts that risk-neutral and risk-averse firms' concentrates on domestic markets at the expense of international trade due to high risk associated with cross border trade.

Foreign exchange reserves refer to money or assets, held by Central Bank or other monetary authorities for payment of a country's liabilities (Musembi, 2013). Treasury bills, government bonds, corporate bonds and shares as well as foreign currency loans are examples foreign currencies denominated as marketable securities (Cinel & Yamak, 2014). The exporters in a nation deposit their foreign currencies into their local banks in order to complete their transactions. The banks therefore transfer those foreign currencies to the central bank of that particular country. In Kenya, international trade is mostly done using US dollars and therefore the Central Bank of Kenya holds reserves inform of U.S dollars.

The central bank of Kenya Act 2015 obligates the bank to maintain adequate official foreign exchange reserves that is usually equal to the value of the country's quarterly imports. The foreign exchange reserves are used to service the government external debts and non-debt government external obligations as well as cushion against external crises. The primary objective of the central bank is to use the foreign exchange reserves when deemed necessary to smoothen the uncertainty in exchange rates.

A report by the Central Bank of Kenya indicated that in the first month of 2019 the foreign reserves decreased from $8.83 billion to $8.69 billion which in turn pushed down the country's import cover. The fall in the foreign reserves was due to CBK selling activities in the open market in a bid to prevent high exchange rate volatility. Another possible cause of the fall in foreign exchange reserves may have been due to the CBK usage of the dollars to settle Kenya's foreign debt obligations (Okaro, 2017). Foreign exchange reserves in Kenya averaged $4.586 billion from 1995 reaching an all-time high level of $12.264 billion in

July 2018. The lowest ever witnessed level of foreign reserve in Kenya was $853 million in November 1995 (Okaro, 2017).

A study by Oshota and Badejo (2015) indicates that developing economies with floating exchange rate have current account deficits exceeding 5% ceiling which has detrimental effects on the trade flows. This is evident in developing economies like Kenya whereby the unfavorable balance of trade has been very huge due to instabilities in the exchange rate. The Kenyan currency has been losing value over time when compared to U.S dollar (Vass, 2013). However, there is generally lack of consensus on the effects of exchange rate volatility on international trade (Breitenbach *et al*., 2017). The study took into account the foreign reserves since they influence the relationship between international trade and exchange rate volatility. The Kenyan government has attempted to stabilize the volatile exchange rate by implementing a managed float exchange rate regime, which permits the central bank of Kenya to intervene in the markets by purchasing and selling foreign currencies through the use of foreign exchange reserves. The main aim was to analyze the moderating effect of foreign exchange reserves on the relationship between foreign exchange rate volatility and international trade in Kenya.

## II. Literature Review

### *A. Overview of International Trade*

International trade is described as the cross-border exchange of goods and services. Currently, there are rules and regulations controlling international trade whose main objective revolves around mutual benefit for all nations (Kinuthia, 2015). In comparison to the global export, Kenyan export growth rate has been on a reducing trend. In between 2012 and 2013 it decreased by 3%. That was a sharp decline of Kenya shillings 15.5 billion in 2013 and this led to a weaker economic growth rate of 5.7% and this was caused by negative concerns about the outcome of the last general election and investment anxieties due to the devolution of the government. Globally, gains from international trade are accounted for through using the BOP accounts; current account and capital account. International trade is a main indicator of openness and has contributed overwhelmingly to economic growth and prosperity of countries (Sun & Heshmati, 2010). According to Schneider (2004), domestic markets are exposed to increased competition through imports, which benefits the consumers, and prevent being exploited while exporting.

### *B. Risk-Portfolio School of Thought Theory*

Risk-Portfolio school of thought postulates that there is a positive association between exchange rate volatility and international trade flows. De Grauwe (1988) developed a simple model in which a firm producing for both domestic and overseas markets maximize the expected utility of total income under competitive market conditions. The utility function is believed to have only a few constraints. Because pricing is in foreign currency and the exchange rate is arbitrary, export revenues in home currency are unclear. The domestic good, on the other hand, is priced in the local currency. Thus, whether expected marginal utility is convex or concave under a random exchange rate sensitive to some degree of risk aversion affects the reduction in expected utility of export earnings.

According to this theory, higher risk means more opportunities for profit and, as a result, more trade flows. De Grauwe (1988) depicts the predicament of a competitive producer who must choose between selling in the local or overseas market, despite the fact that both marketplaces have set prices. The reaction of the producer to changes in exchange rate, according to this study, is solely determined by whether the projected marginal utility of export income is a concave or convex function of the exchange rate. The study points out that risk-averse people are attracted to bigger earnings and are rarely impacted by negative exchange rates and lower production. The paper examines exchange rate risk in the modern world in light of portfolio diversification, assuming that economic actors will maximize their returns by diversifying their investments and engaging in risk environments that match their returns. The influence of exchange rate volatility on predicted earnings is the focus of this hypothesis. If profits are a convex function of the exchange rate, then more exchange rate volatility will result in higher predicted profits, which will lead to larger trade flows (Choudhry & Hasan, 2007). Therefore, the only risk is the local currency prices of the exports as they determine the revenue flows to the producer under varying exchange rates. The major limitation of this theory is the neglect of firms' response to risks. The high risk-averse environment would boost the usefulness of export earnings and encourage exports to avoid revenue reductions if exchange rate volatility increased.

### *C. Empirical Review*

In Pakistan, Jabeen and Khan (2014) used macroeconomic variables to simulate exchange rate volatility. From April 1982 through November 2011, the study used monthly data on Pak Rupee exchange rates in terms of major currencies and macroeconomic fundamentals. The study used GARCH modeling in analysis and results reveal that foreign reserves have an impact on exchange rate volatility in terms of trade. The

impact of terms of trade, international reserves, and capital flows on the real exchange rate in emerging economies is examined by Aizenman and Riera-Crichton (2008). The study's findings show that overseas reserves help to mitigate the impact of terms of trade shocks on the actual exchange rate. However, research failed to identify estimating methodology or the study's sample time. In order to assess the short and long run association between exchange rate volatility and international trade in Kenya, the current study used the cointegration test.

Nowak, Hviding, and Ricci (2004) investigated the impact of foreign exchange reserves in lowering currency volatility in emerging economies. The study employed a panel of 28 countries over the period 1986-2002. The study's findings show that raising foreign exchange reserves minimizes exchange rate volatility and, as a result, enhances a country's international trade performance. Nteegah and Okpoi (2017) used a cointegration and vector error correction model to study external trade and its effects on Nigeria's foreign exchange reserves. The analysis included data from Nigeria's foreign reserves, oil exports and imports, non-oil exports, and exchange rate from 1980 to 2015. The study discovered that export volume and foreign reserves have a positive association, whereas imports and foreign reserves have a negative relationship. Brafu-Insaidoo (2017), Used ARDL in investigating the effect of build-up of international reserves on exchange rate volatility in Ghana and results reveal that that increase in foreign reserves helps to reduce the exchange rate volatility in any given economy. However, statistical evidence of the effect of foreign exchange reserves on the link between foreign exchange rate volatility and international trade was not found in this study. The current study used an error correction model to determine the extent to which exchange rate volatility is regulated by foreign exchange reserves in international trade.

## III. METHODOLOGY

### *A. Research Design*

The study used a causal design (Brewer & Kuhn, 2010), with the goal of determining if foreign exchange rate volatility and international trade had a cause-and-effect connection. The study also employed correlational study design (Penprase *et al*., 2015) which entailed measuring paired variables and establishing the relationship between them without manipulating the independent variable. These research designs indicated how a change in the independent variable influenced the dependent variables alongside establishing the causal dynamic link of foreign exchange rate volatility and international trade.

### *B. Data source*

The data for this study was sourced from the Kenya National Bureau of Statistics website for the period between 1966 to 2018. The data collected included time series data on foreign exchange reserves, foreign exchange rates, balance of trade, inflation rate, interest rate, and gross domestic product. The data that was used included; approved economic reports, validated documents, and historical data.

### *C. Data Analysis*

The stationarity of the data was tested using the Phillips Perron test (PP), differencing the data when necessary to render the data stationary. The Granger Causality test was used to determine the relationship that existed between the variables. To see if there was a long-run equilibrium between the variables, cointegration was used. Finally, diagnostic checks were run to ensure that the Classical linear Regression Model (CLRM) assumptions were met.

Equation (1) was fitted to model the moderating effect of foreign reserves on the relationship between foreign exchange rate volatility and international trade.

$$\Delta\, ln(IT)_t = \beta_0 + \beta_1 \Delta\, ln(ER)_t + \beta_2 \Delta\, ln(FER)_t + \beta_3 \Delta\, ln(ER)_t . \Delta\, ln(FER)_t + \beta_4 \Delta\, ln(INFL)_t + \beta_5 \Delta\, ln(IR)_t + \beta_6 \Delta\, ln(RDI)_t + \beta_7 Dum_1 + \beta_8 Dum_2 + \beta_9\, EC_{t-1} + \mu_t \quad (1)$$

### *D. Diagnostic Test*

#### *1) Multicollinearity Test*

The general intercorrelation among explanatory variables is known as multicollinearity (Gujarati & Porter, 2003). Multicollinearity contradicts the Classical Linear Regression Model assumption that specifies that the explanatory variables should not be multicollinear. The coefficient of determination ($R^2$) and the Variance Inflation Factor (VIF) were used to test if there existed multicollinearity. The null hypothesis which states that independent variables are intercorrelated with the alternative hypothesis stating presence of intercorrelations among independent variables of the model and the decision rule for rejecting the hypothesis is that if the $R^2$ is greater than 0.8, with few significant t-ratios, and the VIF is greater than 10, multicollinearity is likely present. Further, replacing or linearly combining those independent variables which are highly correlated would solve the issue of multicollinearity.

*2) Heteroscedasticity Test*

Heteroskedasticity occurs when the error term's variance varies over time and for all values of the explanatory variable. The null hypothesis states that the variances for the errors are equal while the alternative hypothesis states that the error term variances are not equal. The assumption goes against the standard linear regression model's premise that the error term's variances remain constant. The assumption assures that each observation is equally trustworthy, resulting in unbiased regression coefficient estimations and hypothesis tests. (Gujarati & Porter, 2003). Heteroskedasticity may result to standard errors being misleading and erroneous, causing problems with interval estimation and hypothesis testing. If there is presence of heteroscedasticity problem, it could be fixed through redefining or transforming the dependent variable. Further, use of weighted regression could also be employed to fix the problem of heteroscedasticity. The Breusch-pagan test was used to determine whether the residuals had a constant variance in this investigation. If the P-value is less than 0.05, heteroscedasticity exists.

*3) Autocorrelation Test*

When the variances of the error term are progressively interdependent, autocorrelation arises. The null hypothesis states that there was no correlation among residuals while the alternative hypothesis was that the error terms are autocorrelated. Durbin Watson (DW) test is used to detect autocorrelation. Presence of autocorrelation could be fixed through improving the model fit which allows capturing of the structure of the data in the models. Further, the problem of autocorrelation should also be fixed through inclusion of autoregressive model especially in a scenario where no more predictors could be included in the model. Positive autocorrelation is indicated by a DW value of zero, whereas a DW value of 4 indicates a high level of negative correlation. A DW vale of 2 to 2.5 indicates that there is no association. The presence of autocorrelation was avoided through the right specification of the model's functional form.

## IV. Results and Discussion

### *A. Descriptive Statistics*

The data was subjected to descriptive analysis of the independent variables for the purpose of explaining the behavior of the variables.

TABLE I: Descriptive Statistics

| | *lnINFL* | *LnIR* | *LnFER* | *lnGDP* | *lnEXCHR* | *lnBOT* |
|---|---|---|---|---|---|---|
| Mean | 2.1018 | 1.4413 | 20.3132 | 23.0064 | 3.3280 | 22.1462 |
| Median | 2.2782 | 1.6184 | 20.0134 | 22.8375 | 3.4725 | 22.8695 |
| Maximum | 3.8282 | 3.0491 | 22.8269 | 25.1996 | 4.6384 | 22.9555 |
| Minimum | -1.0032 | -0.0591 | 17.7744 | 20.8756 | 1.9461 | 0.0000 |
| Std. Dev. | 0.8871 | 1.0564 | 1.4125 | 1.1623 | 1.0519 | 3.1804 |
| Skewness | -1.1234 | -0.1979 | 0.3419 | 0.0849 | -0.1778 | -2.5628 |
| Kurtosis | 4.8878 | 1.6722 | 2.1298 | 2.3124 | 1.3050 | 4.0998 |
| Jarque-Bera | 19.0189 | 4.2396 | 2.7045 | 1.107752 | 6.6242 | 4.6487 |
| Probability | 0.000074 | 0.120058 | 0.258658 | 0.574718 | 0.036440 | 0.0000 |
| Observations | 53 | 53 | 53 | 53 | 53 | 53 |

Where;

*ln (BOT)* =Natural logarithm of Balance of Trade
*ln (EXCHR)* =Natural logarithm of foreign exchange rates
*ln (FER)* =Natural logarithm of foreign exchange reserves
*ln (INFL)* =Natural logarithm of Inflation rate
*ln (IR)* =Natural logarithm of Interest rate
*ln (GDP)* =Natural logarithm of Gross Domestic Product

Table I shows the results of the normality test revealed that all of the variables were evenly and normally distributed, with skewness test values ranging from -3 to +3 and kurtosis values ranging from -10 to +10. The skewness of natural logarithm of inflation rate was -1.1234, natural logarithm of interest rate had skewness of -0.1979, implying the data was normally distributed. Natural logarithm of foreign exchange reserves, natural logarithm of gross domestic product and natural logarithm of foreign exchange rate had skewness values of 0.3419, 0.0849 and -0.1778 respectively which portrayed that the data was normally distributed. The jarque Bera test values of natural logarithm of interest rate (*lnIR*), natural logarithm of foreign reserves (*lnFER*), and natural logarithm of gross domestic product (*lnGDP*), were 0.1201, 0.2587, and 0.5747 respectively which are all greater than 0.05 signifying that the variables had normally distributed data.

### *B. Stationarity Test*

The null hypothesis states that the variables in the models are non-stationary while the alternative hypothesis states that the variables are stationary. The decision rule for rejecting the null hypothesis and declaring the presence of a unit root is based on the value of the P-P statistic being greater than the MacKinnon critical values at a 5% level of significance. The variables were initially examined in their level forms, and if they were found to be non-stationary, they were then subjected to the first differencing.

TABLE II: UNIT ROOT TEST FOR VARIABLES IN LEVEL FORM

| Variable | PP Test Statistics | 5% Critical Value | 10% Critical Value | Inference |
|---|---|---|---|---|
| *InINFL* | -3.6406 | -2.9178 | -2.5964 | stationary |
| *InIR* | -4.2925 | -2.9178 | -2.5964 | stationary |
| *InBOT* | -6.2650 | -2.9178 | -2.5964 | stationary |
| *InFER* | -0.9545 | -2.9178 | -2.5964 | non- stationary |
| *InGDP* | -0.3060 | -2.9178 | -2.5964 | non- stationary |
| *InEXCHR* | -0.5284 | -2.9178 | -2.5964 | non- stationary |

From the results in Table II, the PP test statistic values for natural logarithm of inflation rate (*lnINFL*), natural logarithm of interest rate (*lnIR*) and natural logarithm of balance of trade (*lnBOT*) were: -3.6406, -4.2925 and -6.2650 respectively were less than the MacKinnon critical value of -2.9178 at 5% level of significance indicating they were stationary at level. It was also noted that the PP test statistic for natural logarithm of foreign exchange reserves (*lnFER*), natural logarithm of gross domestic product (*lnGDP*), and natural logarithm of exchange rate (*lnEXCHR*) were: -0.9545, -0.3060, and -0.5284 respectively which are greater than the MacKinnon critical values of -2.9178 at 5% significance level which indicates that the variables are non-stationary and therefore rejecting the null hypothesis that variables do not have unit root.

TABLE III: UNIT ROOT FOR VARIABLES AT FIRST DIFFERENCE

| Variable | PP Test Statistics | 5% Critical Value | 10% Critical Value | Inference |
|---|---|---|---|---|
| *InFER* | -8.0945 | -2.9190 | -2.5970 | stationary |
| *InGDP* | -4.9613 | -2.9190 | -2.5970 | stationary |
| *InEXCHR* | -5.4738 | -2.9190 | -2.5970 | stationary |

Results in Table III, show that data on natural logarithm of foreign exchange reserves (*lnFER*), natural logarithm of gross domestic product (*lnGDP*), and natural logarithm of foreign exchange rate (*lnEXCHR*) were stationary after the first differencing was conducted as depicted by the PP statistical values which were less than Mackinnon critical values at 5% significance level. The PP test statistic values for natural logarithm of foreign exchange reserves (*lnFER*), natural logarithm of gross domestic product (*lnGDP*), and natural logarithm of exchange rate (*lnEXCHR*) were: -8.0945, -4.9613, and -5.4738 respectively whereby at a 5% significance level, these values were less than the MacKinnon critical values of -2.9190, indicating that all variables are stationary at first difference. As a result, the null hypothesis for non-stationary was not supported by the study.

### *C. Cointegration Test*

The procedure included determining whether or not there is a long-run relationship between foreign exchange rate volatility and international trade. The test entailed estimating the parameters using ordinary least square (OLS) and then determining if the resulting residuals were stationary. The decision rule was to reject the null hypothesis of no cointegration if the trace statistic values were greater than the 5% critical value. The suitable lag length that minimized the Akaike information criteria (AIC) value was adopted in this process.

TABLE IV: COINTEGRATION TEST FOR INTERNATIONAL TRADE VOLUMES MODEL

| Unrestricted Cointegration Rank Test (Trace) | | | | |
|---|---|---|---|---|
| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob.** |
| None * | 0.7127 | 195.5134 | 125.6154 | 0.0000 |
| At most 1 * | 0.6092 | 133.1570 | 95.7537 | 0.0000 |
| At most 2 * | 0.4878 | 86.1778 | 69.8189 | 0.0014 |
| At most 3 * | 0.3715 | 52.7242 | 47.8561 | 0.0163 |
| At most 4 | 0.3390 | 29.5052 | 29.7971 | 0.0540 |

Table IV shows that using the Juselius Johansen cointegration test, the long-run relationship between international trade volumes and the independent variables was examined. The decision rule was to reject the null hypothesis that no cointegration if the values of the Trace statistics are greater than 5% critical value and fail to reject the null hypothesis if the results are otherwise.

The first null hypothesis indicated that there is no cointegrating equation. The trace statistic is greater than the critical value 195.5134>125.6154 implying presence of cointegration and rejecting the null

hypothesis. The second null hypothesis showed that the trace statistic value is greater than the critical value since 133.1570>95.7537 hence rejecting the null hypothesis and conclude that there is at most 1 cointegrating equation. The third null hypothesis, the trace statistics was greater than the critical value 86.1778>69.8189 hence we reject the null hypothesis and conclude that there is at most 2 cointegrating equations. The fourth null hypothesis shows that trace statistic is greater than the critical value because 52.7242> 47.8561 hence rejecting the null hypothesis and conclude there was at most 3 cointegrating equations. The fifth null hypothesis implied that the trace statistic was less than the critical value since 29.5052<29.7971 hence failure to reject the null hypothesis that there are at most 4 cointegrating equations. We finally conclude that there was presence of cointegration showing presence of long-run relationship between international trade volumes and the independent variables.

### *D. Granger Causality Test*

International trade models were subjected to a Granger causality test. The null hypothesis of no causality was tested by comparing the p-value to the critical value at a significance level of 5%. The results of the test are shown in Table V.

TABLE V: GRANGER CAUSALITY TEST RESULTS FOR INTERNATIONAL TRADE VOLUMES MODEL VARIABLES

| Null Hypothesis | Obs | F-Statistics | Prob. |
|---|---|---|---|
| *lnIR* does not Granger Cause *lnBOT* | 51 | 0.5980 | 0.5541 |
| *lnBOT* does not Granger Cause *lnIR* | | 0.3361 | 0.7163 |
| *lnINFL* does not Granger Cause *lnBOT* | 51 | 0.1960 | 0.8227 |
| *lnBOT* does not Granger Cause *lnINFL* | | 0.0976 | 0.9072 |
| *lnGDP* does not Granger Cause *lnBOT* | 51 | 3.3313 | 0.0446 |
| *lnBOT* does not Granger Cause *lnGDP* | | 0.0618 | 0.9401 |
| *lnFER_lnEXCHR* does not Granger Cause *lnBOT* | 51 | 2.1325 | 0.1301 |
| *lnBOT* does not Granger Cause *lnFER_lnEXCHR* | | 0.0517 | 0.9497 |
| *lnFER* does not Granger Cause *lnBOT* | 51 | 4.1429 | 0.0222 |
| *lnBOT* does not Granger Cause *lnFER* | | 0.0059 | 0.9941 |
| *lnEXCHR* does not Granger Cause *lnBOT* | 51 | 1.5673 | 0.2195 |
| *lnBOT* does not Granger Cause *lnEXCHR* | | 0.2255 | 0.7990 |

From Table V, the natural logarithm of balance of trade (*lnBOT*) and natural logarithm of interest rate (*l51nIR*) showed neutral causality as implicated by the p-values of p=0.5541>0.05 and p=0.7163>0.05. As a result, the null hypothesis of no granger causality between natural logarithm of interest rate and natural logarithm of balance of trade was not rejected. This implied that neither the natural logarithm of balance of trade nor the natural logarithm of interest rate causes each other. Similarly, neutral causality was observed between natural logarithm of inflation rate (*lnINFL*) and natural logarithm of balance of trade (*lnBOT*) as depicted by the p-values of p=0.8227>0.05 and p=0.9072>0.05 respectively. Therefore, failure to reject the null hypothesis that no granger causality between natural logarithm of inflation rate and natural logarithm of balance of trade implying that neither the natural logarithm of inflation rate nor the natural logarithm of balance of trade causes each other. A unidirectional causality was observed between natural logarithm of balance of trade (*lnBOT*) and natural logarithm of gross domestic product (*lnGDP*) as shown by the p-values of p=0.0446<0.05 and p=0.9401>0.05 respectively. This implied that natural logarithm of gross domestic product granger causes natural logarithm of balance of trade hence rejecting the null hypothesis that natural logarithm of gross domestic product does not granger cause natural logarithm of balance of trade while on the other hand, because the p-value is greater than 0.05, the null hypothesis that natural logarithm of balance of trade does not impact natural logarithm of gross domestic trade is not rejected. The natural logarithm of balance of trade (*lnBOT*) and natural logarithm of the moderating variable (*lnFER_lnEXCHR*) showed a neutral causality as indicated by the p-values of p=0.1301>0.05 and p=0.9497>0.05 respectively resulting in the failure to reject the null hypotheses implying that the natural logarithm of balance of trade and the natural logarithm of the moderating variable does not influence each other. A unidirectional causality exists between natural logarithm of balance of trade (*lnBOT*) and natural logarithm of foreign exchange reserves (*lnFER*) as depicted by the p-values of p=0.0222<0.05 and p=0.9941 respectively hence rejecting the null hypothesis that natural logarithm of foreign exchange

reserves does not influence natural logarithm of balance of trade. A neutral causality exists between the natural logarithm of balance of trade (*lnBOT*) and the natural logarithm of the foreign exchange rate (*lnEXCHR*) as depicted by the p-values of p=0.2195 and p=0.7990 which implied that neither the natural logarithm of balance of trade nor the natural logarithm of foreign exchange rate causes each other.

### *E. Estimation of the Model- Moderating Effect of Foreign Exchange Reserves on the Relationship between Foreign Exchange Rate Volatility and International Trade Volumes in Kenya*

Table VI shows regression results for the existence of a long-run relationship between natural logarithm of foreign exchange rate volatility (*lnEXCHR*) and natural logarithm of international trade volumes (*lnIT*) moderated by natural logarithm of foreign exchange reserves (*lnFER*). The coefficients of the constant, natural logarithm of foreign exchange rate (*lnEXCHR*), natural logarithm of foreign exchange reserves (*lnFER*), natural logarithm of moderator variable (*lnFER_lnEXCHR*), natural logarithm of gross domestic product (*lnGDP*), natural logarithm of inflation rate (*lnINFL*), natural logarithm of interest rate (*lnIR*), dummy representing exchange rate regimes (dummy1) and dummy representing structural breaks (dummy2) were: -8.3713, 16.0927, 2.3396, -0.7991, -0.6896, -0.0619, -0.1546, 1.0839, and -0.5346 respectively.

TABLE VI: VECTOR ERROR CORRECTION MODEL RESULTS FOR FOREIGN EXCHANGE RATE VOLATILITY EFFECTS ON INTERNATIONAL TRADE VOLUMES

| Variable | Coefficient | Std. Error | t-Statistics | Prob. |
|---|---|---|---|---|
| Constant | -8.3713 | 12.9329 | -0.6473 | 0.5210 |
| *lnEXCHR* | 16.0927 | 3.0890 | 5.2097 | 0.0000 |
| *lnFER* | 2.3396 | 0.6732 | 3.4751 | 0.0012 |
| *lnFER_lnEXCHR* | -0.7991 | 0.1513 | -5.2819 | 0.0000 |
| *lnGDP* | -0.6896 | 0.4545 | -1.5172 | 0.1367 |
| *lnINFL* | -0.0619 | 0.1509 | -0.4105 | 0.6835 |
| *lnIR* | -0.1546 | 0.1337 | -1.1568 | 0.2539 |
| Dummy1 | 1.0839 | 0.9127 | 1.1876 | 0.2417 |
| Dummy2 | -0.5346 | 0.3495 | 1.5296 | 0.1336 |
| R-squared | 0.9557 | Mean dependent var | - | 22.1314 |
| Adjusted R-squared | 0.9462 | S.D. dependent var. | - | 3.2095 |
| S.E. of regression | 0.7444 | Akaike info criterion | - | 2.4185 |
| Sum squared resid | 23.2718 | Schwarz criterion | - | 2.7937 |
| Log likelihood | -52.8807 | Hannan-Quinn criter. | - | 2.5623 |
| F-statistic | 100.6818 | Durbin-Watson stat | - | 2.4590 |
| Prob(F-statistic) | 0.000000 | Mean dependent var | - | 22.1314 |

The regression constant was -8.3713 implying the international trade volumes when other factors are zero. The model was found to be significant as indicated by the p-value of 0.000<0.05 hence rejecting the null hypothesis that the model is not significant. The $R^2$ was 0.9557 implying that the independent variables predicted 95.57% of changes in international trade volumes in the model. The model is represented in Equation (2).

$$lnIT = -8.3713 + 16.0927lnEXCHR + 2.3396lnFER - 0.1546lnIR - 0.6896lnGDP - 0.0619lnINFL - 0.7991lnFER\_lnEXCHR + 1.0839Dummy1 - 0.5346Dummy2 \quad (2)$$

There existed a positive significant relationship between natural logarithm of international trade volumes and natural logarithm of foreign exchange rate whereby a 1% unit change in foreign exchange rate would result to 16.0927% units change in international trade volumes in the same direction. The results were contradictory to those of Hooper and Kohlhagen (1978) who revealed that in the long-run foreign exchange rate volatility affects the international trade negatively. A positive relationship existed between international trade volumes and foreign exchange reserves as indicated by the positive coefficient whereby a 1% unit change in foreign exchange reserves would result to 2.3396% units change in international trade volumes in the same direction. The results are accordant to the findings of Jabeen and Khan (2014) who found that foreign exchange reserves had significant influence on exchange rate volatility in the terms of trade. Similarly, the results were coherent to findings of Aizenman and Riera-Crichton (2008) who demonstrated that international foreign exchange reserves protect the real exchange rate from the effects of terms of trade shocks.

The relation between natural logarithm of interest rate and natural logarithm of international trade volumes depicted a significant negative association whereby a 100% unit change in interest rate would result to 15.46% units change in international trade volumes in the opposite direction. The relationship between gross domestic product and international trade volumes depicted a significant negative association whereby 100% units change in gross domestic product would result to 68.96% units change in international trade volumes in the opposite direction. The relationship between natural logarithm of inflation rate and

natural logarithm of international trade volumes depicted a significant negative association whereby 100% units change in inflation rate would result to 6.19% units change in international trade volumes in the opposite direction. There existed a negative relationship between natural logarithm of international trade volumes and the natural logarithm of moderator variable since 100% units change in the moderator variable would result to 79.91% units change in international trade volumes in the opposite direction implying that the effects of foreign exchange rate volatility are inversely related to the moderating variable. This implies that when a moderator variable is launched to the model, the overall impact of volatility on the international trade is minimized.

The dummy variable representing foreign exchange regime positively influences international trade as exhibited by a positive coefficient. This could be attributed to the ease of doing international trade under flexible exchange regimes whereby forces of demand and supply determined level of exchange. The dummy variable representing the structural breaks captured under this study exhibited negative effect on international trade volumes which was attributed to economic activities disruptions witnessed adversely affected international trade.

### *F. Diagnostic Tests*

After conducting the model estimation, diagnostic tests were run to see if the classical assumption of the ordinary least squares had been met. Diagnostic tests are essential for evaluating model residuals and determining model suitability. Multicollinearity, autocorrelation, and heteroscedasticity tests are among the diagnostic tests conducted.

#### *1) Test for Multicollinearity*

Multicollinearity was tested using coefficient of multiple determination ($R^2$) and t-ratios and variance inflation factor (VIF). The international trade model had a coefficient of determination ( $R^2$ ) of 0.9557 and significant t-ratios which implied absence of multicollinearity. Results of the Variance Inflation Factor further indicated absence of multicollinearity.

TABLE VII: VARIANCE INFLATION FACTOR RESULTS

| Dimension | VIF (model) |
|---|---|
| *LnEXCHR* | 5.2950 |
| *LnIR* | 1.2722 |
| *LnINFL* | 1.1642 |
| *lnGDP* | 4.8764 |
| *lnFER* | 1.2211 |

The Table VII shows results of Variance Inflation Factor (VIF) test which was used to investigate if multicollinearity exists in the models. The VIF indicator illustrates how much the standard errors are inflated due to multicollinearity. The VIF is the reciprocal of tolerance level and the basis of rejecting the null hypothesis that there is no multicollinearity is based on the value of VIF. If the VIF value exceeds 10, there is presence of multicollinearity. All the values of VIF values were less than 10 which was a strong indication that there is no multicollinearity in all the models.

#### *2) Heteroscedasticity Test*

Heteroscedasticity was assessed in this study by using the Breusch-Pagan test to see if the residual had a constant variance. The null hypothesis stated that the residuals variances were equal while the alternative hypothesis stated that the error term variances are not equal. If the P-value of the chi-square statistic is less than 0.05, heteroscedasticity is present. The results are presented in the Table VIII.

TABLE VIII: BREUSCH-PAGAN TEST FOR HETEROSCEDASTICITY

| | Chi-square | Prob>Chi-square |
|---|---|---|
| Model | 5.285362 | 0.5078 |

The results of indicate that the P-value in all three models is greater than 0.05, indicating that the null hypothesis of a constant variance, assuming the absence of heteroscedasticity, hence concluding that the variances of the error term were equal.

#### *3) Autocorrelation Test*

One of the assumptions of the classical linear regression model is that the successive values of the error terms are sequentially independent. The presence of autocorrelation was assessed in the models using the Durbin Watson test statistic.

TABLE IX: AUTO-CORRELATION

| Model | Durbin Watson statistic | Inference |
|---|---|---|
| Model | 0.7792 | No association |

The results in the Table IX shows that Durbin Watson test statistic for models 3 was 0.7792 indicating absence of autocorrelation and implying that OLS estimators are efficient.

### *G. VAR Diagnostics*

The Vector Autoregressive model was estimated and the normality diagnostic test was carried out.

#### *1) Normality of random variable*

The error term must have a normal distribution whose mean is zero with a constant variance for all values in order to use ordinary least square estimation. The Quantile-Quantile plots were used to test the normality of the stochastic term, with the null hypothesis stating that normality does not exist. The results are presented in Fig. 1.

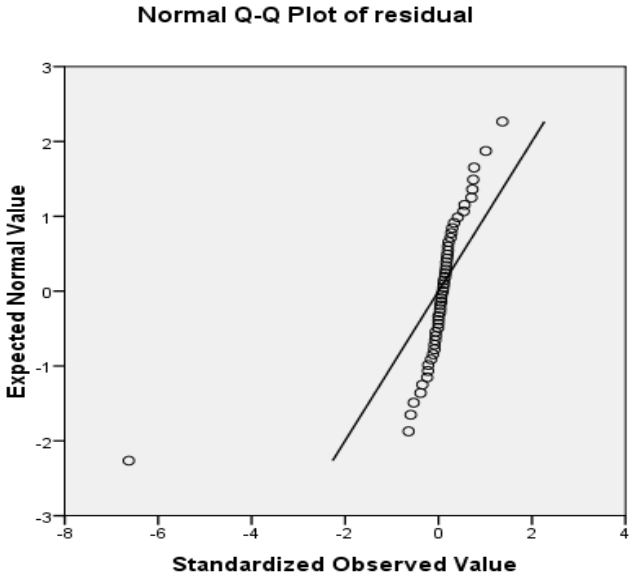


Fig. 1. Q-Q Plot for the Test of Normality of Random Variable of Model.

Fig. 1 above indicates that the Q-Q plot of the residuals lies along a straight line. This implied that in the model, the stochastic term had a normal distribution with a mean of zero and a constant variance hence rejecting the null hypothesis that the random variables are unevenly distributed and concluding that the random variable was normally distributed.

## V. Conclusion and Recommendation

The objective of study was to determine the moderating effect of foreign exchange reserves on the relationship between foreign exchange rate volatility and international trade volumes in Kenya. the results revealed a positive and statistically significant moderating effect of the foreign exchange reserves on foreign exchange volatility and international trade volumes at 5% significant level. The results implied that foreign exchange reserves mitigate the effect of foreign exchange rate volatility on international trade volumes. The coefficient of determination was 0.9557 implied the goodness of fit of model since 95.57% of international trade volumes was predicted by foreign exchange rate volatility and other independent variables moderated by foreign exchange reserves. Foreign exchange reserve was used as a moderator variable purposely for cushioning the effects of exchange rate volatility on international trade volumes in Kenya. The study observed that reserves act as shock absorber against the effects of volatility of the exchange rate. Presence of the reserves serves as cushion to extreme shocks which may affect the performance of trade. Reserves solve the issue of shocks in the exchange rate through increasing availability of foreign currency at the disposal of traders hence reducing the issue of excess demand which may cause increase in prices hence affecting international trade. Therefore, from the study it was concluded that foreign exchange reserves were a crucial element in minimizing the adverse effects of foreign exchange volatility on international trade volumes in Kenya.

### *A. Recommendation*

There should be policies to maintain a large stock of foreign exchange reserves in order to cushion the effects of volatility on international trade. Increasing the reserve ensures that there are always enough foreign currencies to complete transactions which promotes efficiency and effectiveness of trade. Maintaining a large stock of reserves will also ensure that the cost of making a transaction in the cross-border trade is cheaper hence fostering growth of international trade volumes due to favorable trading environment. Further, policies should be enacted to help mitigate the causes of volatile exchange rate

movements instead of majoring on moderating exchange rate movements for the purpose of trade expansion since it is noted that the volatile nature of the exchange rate is attributed to economic shocks or policy regimes. Stability in foreign exchange rate will make the environment for foreign trade more conducive through easing the cost of transactions and increasing the net benefits gained from participating in international trade. Further, the stability in exchange rate will ensure forces of demand and supply work effectively towards achieving equilibrium in the foreign market hence preventing foreign currency deficit which adversely affects transaction by making them too expensive.

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## CONFLICT OF INTEREST

The authors declare no competing interests.

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