Analysis of Exchange Rate Volatility on Trade Balance in Sub-Saharan Africa (SSA): Stochastic Frontier Approach

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Munyentwari Jean Claude[1] & Dr. Afolabi Luqman[2]
[1] Master of Science in Economics, University of Kigali, Rwanda
[2] Senior Lecturer, University of Kigali, Rwanda

Abstract

This study assessed the exchange rate variables and trade balance covering the period from 1990 till 2022 in SSA. The exchange rate variables shall be included in the study are the population growth, The Gross Domestic Product, Real Effective Exchange Rate and the inflation rate. The data was collected from World Bank Group. In this study theories used are theory of efficiency market hypothesis developed by lyke (2020), the Marshall-learner condition developed by (Mahmud & Yucel 2004), J-Curve and Exchange rate pass-through theories. An econometric approach was used to find out answers to the research objectives and hypothesis. A regression analysis was used to find out relationship among variables while a panel VAR and Panel Granger was used to find out the long and short-run relationship among them. Several tests such as stochastic frontier models for panel data, Stationarity, post estimation test like normality, heteroscedasticity, autocorrelation and multicollinearity were conducted in this study. The results of the causality test using the standard Granger causality test demonstrate that there is unidirectional causality from trade balance to population growth, gross Domestic Product, inflation and real effective exchange rate. The estimation techniques including the fully modified ordinary least squares (FMOLS), Dynamic ordinary least squares (DOLS), and Canonical cointegration Regression (CCR) were used to test the consistency and Robustness of the results that were generated using the ARDL bounds testing method. This study will help the policy makers, the government authorities, the researchers and scholars to understand the exchange rate volatility on the trade balances of SSA's economies.

1. Introduction

One of the goals of macroeconomics policies is to achieve on the reduction of the effects of exchange rate in order to have the favorable trade balance. Globally exchange rate effects in the economies deteriorate the terms of trade as well as balance of payments which increase the inflation, unemployment and reduction of economic growth and development.

In free trade economy, effects of exchange rate are unavoidable and they have socio-economic problems for the people who live in the countries where those effects of exchange rate faced. Point of concentration is "does exchange rate causes effects on trade balance, or are they unassociated? " As a result of the publish subscribe pattern in exchange rate effects movement specifically in developing countries like SSA, this problem becoming important.

The Empirical findings from the non-linear model revealed that depreciations improve the trade balance in the long run whereas appreciations have no impact (Ngarambe, 2021)

As expressed in the introduction, SSA is still experiencing exchange rate effects, which may result in the long-run asymmetric effects of REER trade balance. As a result in this perspective, I would like to conduct an exchange rate effects on trade balance in SSA, stochastic Analysis

1.1. Objective of the Study
In general**,** the main objective of this study is to conduct an empirical study on the exchange rate volatility on the Trade balance in SSA.

This study goes after the following specifics objectives**:**

a) To analyze the effect of population growth on trade balance in SSA

b) To analyze the effect of gross domestic product on trade balance in SSA

c) To analyze the effect of real effective exchange rate on trade balance in SSA

d) To analyze the effect of inflation rate on trade balance in SSA

1.2. Research hypothesis
A hypothesis is a tentative proportion which is subject verification through subsequent investigation. It is proposed of what the research that will reveal: the following hypotheses revealed in this research. Null hypothesis (H_0: $\beta_1+\beta_2+…..\beta_n=0$) Exchange rate variables have no significant effect on trade balance in SSA.

Alternative hypothesis (H_1: $\beta_1+\beta_2+….\beta_n=$ different from zero) Exchange rate variables have significant effect on trade balance in SSA.

2. Literature review

The conceptual Framework has blended the viewpoints of several theories of exchange rate, trade balance as highlighted earlier. The conceptual Framework presents the conceptualized interaction among exchange rate effects components and trade balance, this framework postulates that exchange rate would affect the level of trade balance. Trade balance is a dependent variable of the study, while World gross product, the real sub-Saharan gross domestic product and the effective exchange rate are the independent variables, According to the theories The empirical model of Bahmani Oskoee (1985) suggested that following a currency depreciation, the balance of trade deteriorates due to lag structure on exchange rates and then improves it in the long run. In analyzing this behavior, Schaling and Kabundi (2014) revealed that real depreciation improves the South Africa–US trade balance in the long run, hence supporting a J-curve theory. (Razak *et al*., 2019).

The following diagram illustrates conceptual framework of the study.

Independent variables……………………………………………**Dependent variable**

Population growth rate

Gross domestic product

The effective exchange rate

Inflation rate
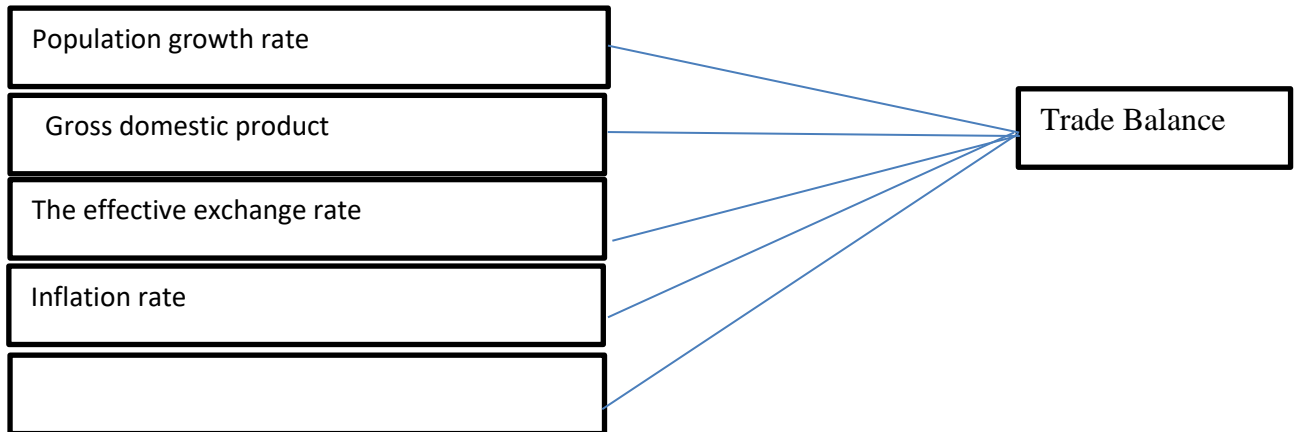
Trade Balance

Gap in literature we found that the majority of these authors used data that did not take into account the exchange rate effects on trade balance after reviewing several empirical works done on the exchange rate effects on trade balance in some countries around the world economies, these empirical works were done in Africa and other countries in the world economies. In order to push the boundaries of knowledge in this particular direction, this study drew on data collected between the years 1990 and 2022 in SSA in order to provide an accurate portrait of the situations that currently exist in SSA. Equally , we deviated in the choice of analytical technique by adopting the robust econometric s tool autoregressive Distribution lag (ARDL), as well as other estimation technique , including Fully modified ordinary least squares(FMOLS), Dynamic ordinary least square (DOLS), Static ordinary least squares (SOLS), and conical co integrating regression (CCR). This study will fill this gap by analyzing the effects of exchange rate such as gross domestic product, population growth, the real effective exchange rate and inflation on trade balance.

3. Research methodology
The research methodology is the procedure used to collect data for the purpose of making Research-based decisions. In this study it includes two subsections, The first contain the technique and the second addressed the methods of data analysis.

3.1. Research Design
This study was used a panel data research design and Augmented Dickey Fuller Test for Stationality, Kao cointegration Test for testing the long run relationship of the variables , the stochastic frontier model test ,the Panel vector auto regressive test for testing the dynamic linear equations where all the variables in the system are treated as endogenous , the Panel Granger test in order to test the the granger causality test within the variables and Lag selection Criteria in order to assist researcher the fitting a VAR of the correct order . this study also was used the Post estimation Test such as Normality test to test if the data set is well-modeled by a normal distribution , Heteroskedasticity test,,Multicollinearity Test and Impulse Response Analysis for examining the effect of one time shock to one of the innovation on the current and future values of the endogenous variables. which is a type of yearly design and was attempted to find out the exchange rate effect relationships among the trade balance in SSA.

3.2 Study Population
The population of this study is a panel data on the population growth rate in sub-saharan africa , the SSAdomestic product , the effective exchange rate of SSA   and inflation rate in

SSA. This research will cover 33 years from 1990 to 2022.

3.3.Model specification

Hypothesis testing

A hypothesis is a tentative proportion which is subject verification through subsequent investigation. It is proposed of what the research that will reveal: the following hypotheses revealed in this research. Null hypothesis (H_0: $\beta_1 + \beta_2 + \ldots . \beta_n = 0$) Exchange rate variables have no significant effect on trade balance in SSA.

Alternative hypothesis (H_1: $\beta_1 + \beta_2 + \ldots . \beta_n =$ different from zero) Exchange rate variables have significant effect on trade balance in SSA.

Functional form and econometric model

Since the relationship between the variables of exchange rate are not linear in reality. The study has been used the log-linear functional form to estimate the relationship between the variables of exchange rate. The trade balance function is specified as follow; the variables are Trade balance (TB), Population Growth (POPGR), Gross Domestic Product (GDP) Real Effective Exchange Rate (REER) and Inflation rate (INFL).

$$TB_{it} = \beta o POPGR_{it}{}^{\beta 1} GDP_{it}{}^{\beta 2} REER_{it}{}^{\beta 3} INFL_{it}{}\ e^{uit}$$

Where **TB_{it}** stands for Trade Balance, **$POPGR_{it}$,** Population Growth, **GDP_{it}** , Gross Domestic Product **,$REER_{it}$** Real Effective Exchange Rate, **INFL** Inflation Rate,.**e** natural logarithm and **U_t** error term. Basing on our function, econometric model.

To obtain estimates of the parameters, the model was transformed into linear one by introducing natural logarithm, thus the model will become as follow;

$$lnTB_{it} = ln\beta o + \beta 1 POPGR_{it} + \beta 2 lnGDP_{it} + \beta 3 lnREER_{it} + \beta 4 lnINFL_{it} + \ U_{it}$$

Assuming that **$ln\beta o = \alpha$**

The equation will become, **$lnTB_{it} = \alpha + \beta 1 lnPOPGR_{it} + \beta 2 lnGDP_{it} + \beta 3 lnREER_{it} + \beta 4 lnINFL_{it} + U_{it}$**

Where **$lnTB_{it}$** stands for the natural logarithm of Trade balance, ln**POP_{it}** is the natural logarithm of Population growth, **GDP_{it}** is the natural logarithm of Gross Domestic Product, and **$lnREER_{it}$** is the natural logarithm of Real Effective Exchange Rate and L_n **INFL** is the natural Logarithm of inflation rate . The error term (ui_t) will be included to represent other variables that can have insignificant influence on dependent variables and found all the errors of measurements, parameter variations, and all the errors of the functional approximation.

Panel vectorautoregression model specification

PVAR is a system of dynamic linear equations where all the variables in the system are treated as endogenous. The form of the system possesses one equation for each variable, which specifies each variable as a function of the lagged values of their own and all other variables in the system. Since we have more than two variables and we expect to have simultaneity among variables, it is better to treat all variables as endogenous. The Application of Stochastic frontier Analysis (SFA); The theory usually presents the producers as successful optimizers. They maximize production, minimize cost and maximize profits. Conventional econometric techniques build on this base to estimate production /cost/ profit function parameters using regression techniques where deviations of observed choices from optimal ones are modeled as statistical noise. Econometric estimation techniques should for the fact that deviations of observed choices from optimal ones are due to two factors: failure to optimize i.e, inefficiency

due to random shocks. Stochastic Frontier Analysis is one such technique to model producer behavior. Based on benchmarking, that is a unit's performance is compared with a reference performance (so- called efficient frontier). Unit's inefficiency can results from technological deficiencies (technical inefficiency) or non-optimal allocation of resources into production (allocative inefficiency). Both technical and allocative inefficiencies are included in cost (economic) inefficiency. (Andrea Furkova, 2008) . Stochastic frontier models allow to analyse technical inefficiency in the frame-work of production functions. It also possible that the frontier shifts, indicating technical progress.in addition, production units can move along the frontier by changing input quantities. the stochastic frontier method allows to decompose growth into changes in efficiency, thus extending the widely used growth accounting method. (Cmilla Mastromacro, 2008). For those discussed methodology of stochastic frontier Analysis, it is the reason why this study captured of using Stochastic Frontier Model Analysis.

The PVAR model was used in this study as it is better than the other models to deal with simultaneity. The PVAR model with 5 variables (TB, POPGR, GDP, REER and INFL) will be specified as follow:

$$\mathbf{lnTB_{it}} = \alpha + \sum_{i=1}^{k} \delta i \mathbf{lnTB_{it-i}} + \sum_{j=1}^{k} \gamma j \ \mathbf{lnPOPGR_{it-j}} + \sum_{m=1}^{k} \beta m \ \mathbf{GDP_{it-m}} + \sum_{n=1}^{k} \varphi n \ \mathbf{REER_{it-n}} + \alpha n \mathbf{INFL_{it-n}} + \mathbf{e_{1it}}$$

Where the e's are the stochastic error terms, it is called impulses or innovations or shocks in the language using of VAR and k is a lag length. Before estimating the equations the maximum lag length (k) shall be determined using Akaike Information Criteria (AIC).

3.4. Post estimation techniques

This research has been used the post estimation test such as Normality, Heteroscedacity, Autocorrelation, and Multicollinearity.

3.5. Data source

The study has been used a published time series secondary data from 1990 till 2022. The data set has been collected from the World Bank Group. The time frame covers the period 1990-2022, covering data on the variables of Trade balance in SSA, SSA population growth, SSA GDP, real effective exchange rate and inflation rate.

The Panel data that has been used in this study are the Trade balance in SSA, the SSA population growth rate, SSA GDP in percentage, real effective exchange rate in percentage and inflation in percentage. The choice of using annual data is based on the fact that it takes a whole year for GDP to have an impact on the trade balance and economic growth, a growing number of recent research analyses the trade balance impact on economic growth, however, ambiguous results of studies imply the need for the research as the deteriorating trade balance hinders economic growth (Deimante Blavasciunaite, 2020)

4. Research findings

This chapter presents and discusses the results of the study. The Analysis of exchange rate volatility on trade balance in sub-Saharan Africa was assessed in accordance with the research objectives.

4.1. Descriptive statistics

Table 1 presents descriptive statistics for variables used in the estimation. Table 1 shows that all the series display a high level of consistency as their mean and median values are perpetually within the maximum and minimum values of the series.

Table 1:Descriptive Statistics

Variables	TB	REER	POPGR	INFL	GDP
Mean	56.66605	196.7360	2.531743	50.42182	1398.010
Median	53.29350	100.4210	2.660626	6.131795	729.7091
Maximum	163.6187	96626.00	16.62550	23773.13	10273.80
Minimum	2.698834	47.00247	-16.88063	-16.85969	99.75725
Std. Dev.	23.24990	2881.603	1.276155	741.8927	1694.941
Skewness	1.216429	33.44350	-4.431396	29.55931	2.313047
Kurtosis	5.526350	1119.645	106.9394	935.3074	8.529618
Jarque-Bera	575.0831	58501588	508730.8	40798356	2429.944
Coeff. Of variation (cv)	0.409969	1.212615	14.70940	14.64583	0.277631
Probability	0.000000	0.000000	0.000000	0.000000	0.000000
Sum	63579.30	220737.8	2840.616	56573.28	1568567.
Sum Sq. Dev.	605965.3	9.31E+09	1825.628	6.17E+08	3.22E+09
Observations	1122	1122	1122	1122	1122

Source: Author's computation

In this table, coefficient of variation (CV) was computed to help compare the degree of variation of the mean of our variables since they are expressed in different measurements. The table reveals that trade balance ratio in SSA for the period between 1990 and 2022 had a mean of 56.69290   from minimum of 2.698834 to a maximum of   163.6187 within a standard deviation of 23.24287   and the coefficient of variation of 0.409969 Population growths (POPGR) had mean of 2.531734   from minimum of -16.88063   to maximum of 16.62550 and within a standard deviation 1.276724   and the coefficient of variation of 0.504285   . Gross Domestic Product (GDP) had mean of 1398.340   from minimum of 99.75725   to maximum of 10273.80   within standard of deviation of 1695.662   and the   coefficient of variation of 1.212615. Real effective exchange rate (REER) had mean of 196.8400 . from minimum of 47.00247to the maximum of 96626.00   within standard deviation of 2882.887   and coefficient of variation of 14.64583. Inflation rate (INFL) had mean of 50.45915   from minimum of - 16.85969 to the maximum of 23773.13 within the Standard deviation of742.2228   and the coefficient of variation of 14.70940.   Inflation Rate (INFL) displays the highest level of dispersion with coefficient of variation of 14.70940.

4.2. Panel unit root   results

Table 2:Panel unit root summary results

VARIABLES	PP- FISHER CHI SQUARE T-STATISTICS and PROBABILITY (ABSOLUTE VALUES)		I'M, PESARAN ANGSHIN W-ST and PROBABILITY (ABSOLUTE VALUES)		ORDER OF COINTEGRATION
	AT LEVEL	AT FIRST DIFFERENCE	AT LEVEL	AT FIRST DIFFERENCE	
Log TB	t-stat:78.82 pr:0.17	Stat:804.528 Prob:0.00	t-stat:1.62582 pr:0.0520	Stat:-18.4586 Prob:0.00	I(1)
Log REER	t-stst:275.519 prob:0.00	t-stat:719.252 prob: 0.00	t-stat:5.19 Prob:0.00	t-stat:22.06 prob:0.00	I(0)
Log POPGR	t-stat:150.345 prob:0.00	t-stst:400.143 prob:0.00	t-stat:10.41 prob:0.00	t-stat:20.67 prob:0.00	I(0)
logINFL	t-stat:327.56 prob:0.00	t-stat:918.18 prob:o.00	t-stat:10.24 prob:0.00	t-stst:27.19 prob:0.00	I(0)
LogGDP	t-stat:1.00 prob:1.00	t-stat:608:18 prob:0.00	t-stat:6.18 prob:1.00	t-stat:16.77 prob:0.00	I(1)

Source: Author's computation

Panel unit root test, interpretation

As indicated in table2, the null hypothesis of unit root is only not rejected for Trade Balance (TB) and Gross Domestic Product (GDP) at level i.e. it's probability is greater than 0.05 hence they are stationary at first difference. However, Real Effective Exchange rate (REER), Population Growth (POPGR), Inflation (INFL) are stationary at level. As shown on the table2, their probabilities are less than 0.05.

4.3. Kao Cointegration Test For Long Relationship

The stationarity test confirmed that the variables are integrated of different orders where by some are I(1) while others are 1(0). Therefore, performing a cointegration to establish whether the long-run relationship exists or not. The Kao Test for cointegration was performed to see if there is exist along-run relationship among the dependent variables and independent variables.

H_O: No cointegration equation

H_1: H_O is not true

Conclusion: Reject the null hypothesis (H_O) if the t-statistics is greater than value (5%,)

Table 3:Result of Kao cointegration test

	STATISTICS	P-VALUE
MODIFIED DICKEY FULLER T	-4.4151	0.0000
DICKEY- FULLER T	-3.3667	0.0004
AUGMENTED DICKEY-FULLER T	-2.3730	0.0088
UNADJUSTED MODIFIED DICKEY-FULLER T	-6.0381	0.0000
UNADJUSTED DICKEY- FULLER T	-4.0340	0.0000

Source: Author's computation using STATA13

The results from the Table6 (Appendix), showed that the null hypothesis state that there is no cointegration and the alternative hypothesis, that the panels are cointegrated.

As the p-value of the modified Dickey-Fuller t is 0.0000 and it is less than 0.05, the null hypothesis is rejected therefore we conclude that the panels are cointegrated.

The results of the Kao cointegration test confirm the existence of a level relationship among the variables since the t-statistics is above the value of significance level suggesting the rejection of the null hypothesis of no level relationship.

The result illustrates that the value of t-statistic of Modified Dickey-Fuller in absolute value of 4.41 is larger than the critical value at 5% level of significance which confirms the presence of a long-run relationship between the dependent variable (Trade balance) and independent variables.

4.4. Stochastic frontier model for panel data

Table 4: Results of Stochastic Frontier model   test

LogTB	coefficients	z	P > $\mid z \mid$
logPOPGR	0.0521886	1.67	0.096
logINFL	-0.0239867	-3.11	0.002
logREER	-0.0885678	-3.59	0.000
logGDP	0.0673066	3.55	0.000
Cons.	4.360623	18.04	0.000

Source: Author's computation using STATA13

The result in the table shows that inflation has a negative statistically significant impact on trade balance with coefficient of -0.023. This implies that a 1 percent increase In inflation reduces trade balance by 0.023 percent holding other factors constant. This is as expected, as increase in inflation rate will cause negative long run trade balance in SSA. This as expected as the effects of inflation on economic growth in Africa (Arcade Ndoricimpaye, 2017)

The result in the table shows that gross domestic product has a positive statistically significant impact on trade balance with coefficient of 0.067. This implies that a 1percent increase in gross domestic product increase trade balance by 0.067 percent holding other factors constant. This result supports the argument that increase in GDP in SSA increase the competitiveness of the SSA'exports. Which increase their trade balance. The same as the results of this empirical analysis that have leads to the conclusions that terms of trade has a positive relationship with the GDP level in SSA . (Christelle Luengu Mputu, 2016)

The result in the table show that population growth has a positive statistically significant impact on the trade balances with coefficient of 0.052. This implies that 1 percent increase in

population growth increases the trade balance by 0.052 percent holding other factors constant. The result supporting this point suggested that demographic expansion benefits the economy in SSA (Tessema,Henok Fantahun, 2022)

The result in table also shows that real effective exchange rate has a negative statistically significant impact on trade balance with coefficient of -0.088. This implies that 1 percent increase in real effective exchange rate reduce the trade balance by 0.088 percent holding other factors constant. In the article called the impact of the real exchange rate changes on export performance in Tanzania and Ethiopia , the empirical results suggest that , while overvaluation is harmful to exports , undervaluation od the real exchange rate boots export supply as well as export diversification (Kifle Wondemu, David Potts, 2016)

4.5. Panel VAR
Panel Vector Auto Regressive Test

 PVAR is a system of dynamic linear equations where all the variables in the system are treated as endogenous. The form of the system possesses one equation for each variable, which specifies each variable as a function of the lagged values of their own and all other variables in the system.

The PVAR TEST Results from Table3.1 Computed using STATA (Appendix 3.1) showed
The PVAR model with 6 variables (**TB, POPGR, GDP, REER, and INFL**) has been specified as follow:

$\ln TB_t = \alpha + \ln 0.9473493 TB_{t-I} - \ln 0.0076062 POPGR_{t-j} + 0.717318 GDP_{t-m}$ $+ \ln 1.709122 REER_{t-n} + \ln 0.5322152 INFL_{t-n} + e_{1t}$

$\ln GDP_t = \sigma + \ln 0.0112123 TB_{t-i} - \ln 0.1638579 POPGR_{t-j} + \ln 0.910775 GDP_{t-1}$

$- \ln 0.2555395 REER_{t-n} + In - 0.0054892 INFLt_{-n} + e_{2t}$

$\ln REERt = \psi - \ln 0.22 TB_{t-i} + \ln 0.5091112 POGRP_{t-j} + \ln - 0.1464045 GDP_{t-m} + \ln 0.5392095 REER_{t-n} \ln 0.0084055 INFL_{t-n} + e_{3t}$

$\ln INFL_t = 0 + \ln 1.975657 REER_{t-i} + \ln 0.63578 TB_{t-i+} \ln 1.37064 POGRP_{t-j} + \ln 0.717318 GDP_{t-m} + In 0.5322152 INFLt_{-1} + e_{4t}$

$\ln POPG_t = \sigma + \ln 0.0021482 TB_{t-i+} \ln 0.5091112 POPGR_{t-j} . \ln 0.1464045 GDP_{t-m} - \ln 0.1986478 REER_{t-n} - In 0.0039843 INFLt_{-n} + e_{6t}$

After fitting the reduced-form Panel VAR, we may want to know whether past values of a variables, sy , x , are useful in predicting the values of another variables y, conditional on past values of y, that is , whether x " Granger-causes" y (Granger 1969). This is implemented as separate Wald tests with the null hypothesis that the coefficients may be excluded in an equation of the panel VAR model.

4.6. Panel Granger Test

This test is an extension of Granger Causality test (1969), this method considers the cross-sectional dependence among the countries in the sample (Dumitrescu and Hurlin. 2012). The Dumitrescu-Hurlin test can predict cross-section dependence and cross-section independence.

. Null : X does not homogenously cause Y

.Alt: X does homogenously cause Y

.If p-values is more than 0.05, we fail to reject null hypothesis which means that heterogeneous causality exists across the panel. If p-values is less than 0.05, we reject null hypothesis which means that homogeneous causality exists across the panel.

Table 5:PANEL GRANGER Causality test Results

Null Hypothesis	Chi-square	probability	Granger Causality
INF does not granger cause REER	10.399	0.001	Causality
REER does not granger cause TB	7.091	0.008	Causality
INF does not granger cause GDP	6.697	0.010	Causality
INFL does not granger cause POPGR	10.753	0.001	Causality
REER does not granger cause TB	7.091	0.008	Causality
REER does not granger cause GDP	11.975	0.001	Causality
REER does not granger cause POPGR	7.581	0.006	Causality
GDP does not granger cause POPGR	15.057	0.000	Causality

Source: Author'computation

From The table5(Appedix5) , the pairwise Granger Causality test showed that   Inflation rate granger cause Real Effective Exchange Rate , Real Effective exchange rate granger cause Trade balance ,Inflation rate granger cause Gross Domestic Product , Inflation rate granger cause Population Growth , Real Effective Exchange Rate granger cause Trade balance , ,Real Effective Exchange Rate granger cause Gross Domestic Product ,Real Effective Exchange rate granger cause Population growth   and Gross Domestic Product granger cause Population Growth.

4.7. LAG Selection Criteria

Many selection order statistics have been developed to assist researchers in fitting a VAR of the correct order. Several of these selection-order statistics appear in the VAR output. The varsoc command computes these statistics over a range of lags p while maintaining a common sample and option selection. Varsoc can be used as pre estimation or a post estimation command. When it is used as a pre estimation command, a depvarlist is required, and the default maximum lag is 4.when it is used as a post estimation command, varsoc uses the model specification stored in estname or the previously fitted model. For a given lag p, the LR test compares a VAR with p lags with one with p-1lags.the null hypothesis is that all the coefficients on the pth lags of the endogenous variables are zero.

Table 6:Lag selection criteria results

Lag	J	J-Pvalue	MBIC	MAIC	MQIC
1	154.0919	0.2674993	-742	-133.9081	-372.6996
2	68.79322	0.998801	-603.886	-147.2068	-326.3004
3	59.75083	0.8482024	-388.702	-84.24917	-203.6449
4	17.50467	0.9959641	-206.7217	-54.49533	-114.1932

Source: Author's computation using STASTA13

As indicated in table6 (Appendix); the Matching Adjusted Indirect Comparison (MAIC) was used to choose the appropriate lag length to include in the lag 4 was highlighted by the criteria

4.8. POST ESTIMATION TEST

STATA uses an estimation followed by post estimation analysis paradigm. The post estimation selector knows what is available after any estimation command. It shows the full list of post estimation features that are available after any estimation and it shows only those that are available

Table 7:Post estimation Results

| Log TB	Coefficient	z	P > |z|
(1)	- 0.1200929	-2.51	-0.012

Source: Author's computation using STATA13

The table9 (Appendix) showed that the sum of the coefficients is significantly less than one in SSA, so , this production exhibits decreasing returns to scale. If we doubled the number of machines and workers in SSA, we would obtain less than twice as much output in SSA.(Joel kariel and Antony Savagar , 2022) . Technological improvements , such as claud computing , enable growing returns to scale. Return to scale can increase through higher fixed costs or lower marginal costs.

4.8.1 Normality test

In statistics, normality tests are used to determine if a data set is well-modeled by a normal distribution and to compute how likely it is for a random variable underlying the data set to be normally distributed.

Figure 1**: Normality Result**
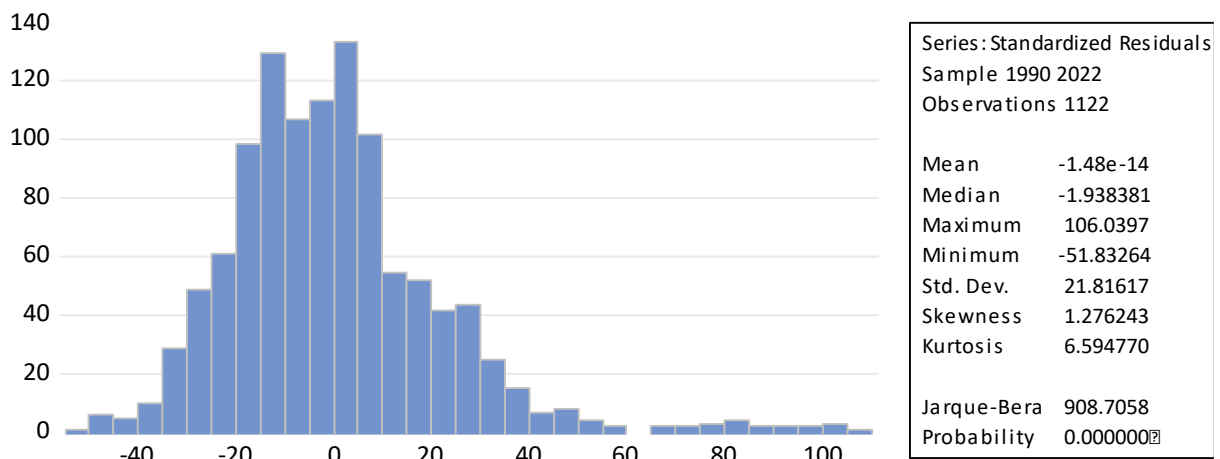
The statistics in the figure 1 reveal that the panel data are not relatively normal as kurtosis value is slightly above 3.0 but not close to 3.0. The skewness value is not close to zero and the Jarque-Bera value is greater than 6, and p-value is less than 0.05 suggesting the rejection of Null hypothesis of normal distribution.

4.8.2. Heteroskedasticity test

One of the assumptions of the classical linear regression model is that series must be homoscedastic. Breaking the assumptions implies that the Gauss-Markov theorem does not apply and therefore the estimators are not the best linear unbiased estimators (BLUE) and their variance is not the lowest of all other unbiased estimators.

Table 8:Result of Heteroskedacity test

Test	Prob. Values Chi-Square
Durbin Watson Stat	0.16

Source: Author's Computation.

We used Heteroskedacity test: Durbin Watson to test our variables. If the computed Chi-Square statistic has a low p value than 5%, we can reject the null hypothesis of homoscedasticity. The result below show that chi-square has a high of0.088 for REER , 0.023 for INFL ,0.067 for

GDP and 0.052 for POPGR. Suggesting that There is heteroscedasticity in our regression we cannot maintain the null hypothesis of homoscedasticity and therefore. The null hypothesis here is that the error variance is homoscedastic.

4.8.3. Test for Multi-Collinearity

The classical linear regression model (CLRM) assumes that there is no exact linear relationship among the regressars (Independent variables). If there are one or more such relationships among the Regressors, we call it multi-collinearity or collinearity. In this study, the issue of multi-collinearity was assessed by variance inflation Factor (VIF) value. The VIF estimates how much the variance of a regression coefficient is inflated due to multi-collinearity presence in the model. To interpret VIF, the thumb rule will be used. For VIF=1, this indicates not corrected, for VIF between 1 and 5; moderately corrected and if it is greater than 5; highly correlation (Green, 2012)

Results from the table11(Appendix) showed that Multi-colliniarity between the GDP and TB is 0.3376 , Multi colliniarity between TB and POPGR IS -0.1281 , Multicollinearity between TB and INFL is -0.0116 and Multicollinearity between TB and REER is -0.0126.

VIF TEST RESULTS

The results from table9 (Appendix) computed using STATA software showed that there is no multi-collinearity from our model. The VIF figures are now all below 5 which highlights a very low correlation between the variables in the model.

4.8.4. Impulse response analysis.

Impulse response analysis was employed in this study to examine the effect of one time shock to one of the innovation on the current and future values of the endogenous variables.

The results of impulse responses on figure5 (Appendix) computed using STATA software showed that trade balance respond differently depending on the explanatory variables and the time of the duration of the shock.

a) Response of logTB to logGDP

Trade balance responded positively to the shock of gross domestic product. The impact slightly increased from period1 to period 5 in the short run and increase from period5 to period10m in the long run.

b) Response of logTB to logINFL

In the short run, trade balance responded positively by the shock of inflation in increasing from period one to period two and in long-run , trade balance responded negatively by decreasing from period three to period ten.

C)Response of logTB to logREER

Trade balance responded negatively by the shock of Real effective exchange rate, from period one time to period five, in the short run and still responded negatively in the long run.

d) Response of logTB to logPOPGR

Trade balance responded positively by the shock of population growth in short-run and continue in positive response in the long-run from period one to period ten.

5. Conclusion

The intention of this research was to analyze the exchange rate volatility on trade balance in SSA from 1990-2022 using secondary Panel data; auto regressive distributed lag model approach was used in the analysis. The study examined the effect of population growth, gross

domestic product, real effective exchange rate and inflation on trade balance. The empirical results and analysis indicated that gross domestic product , real effective exchange rate and inflation and its lags are statistically significant effect on trade balance both in short and long run . Ceteris paribus. Furthermore, the analysis indicated that population growth and real effective exchange rate has no statistically significant effect on trade balance.

The result interpretation and analysis indicated that all our variables were not stationary at levels but those that were not stationary at level became stationary upon first differencing using the PP-FISHER CHI SQUARE and PESARAN ANGSHIN WEST 't-statistics and probabilities. The analysis indicated that our selected variables are not suffered by multicollinearity effects. The Kao cointegration confirmed there is existence of long-run relationship between our variables. Furthermore, the impulses response analysis indicated a positive response of trade balance in short run and long run and exhibiting the negative response to one time shock on the inflation rate in long run, real effective exchange rate and population growth in short run and long run.

6. Recommendations

SSA countries requires providing support to micro, small and medium sized enterprises which are essential sources of job and important actors in the process of linkage building. Securing them access to affordable loans should be a priority.

SSA countries need to engineer their own solutions to the developmental bottlenecks that they face. The obligations under WTO rules, investment treaties, trade agreements, and aid conditions considerably restrict their policy options and the instruments for industrial policy that they can use. In view of their structural development problems, and as latecomers to industrialization, they need to be guaranteed sufficient policy space to find their own solutions to their specific problems.

7. Acknowledgement

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