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IMPACT OF EXCHANGE RATE VOLATILITY ON ECONOMIC GROWTH IN SUB-SAHARAN AFRICAN COUNTRIES

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Abstract

The level of fluctuation in exchange rates has prompted scholars and decision-makers to examine the kind and scope of exchange rate movements' effects on economic growth. The influence of exchange rate volatility on the economic growth of the SSA countries was examined using annualized panel data for the years 2000–2022, with real gross domestic product as the dependent variables for a robust analysis. The study included terms of trade and interest rate as control variables in accordance with the Mundell-Flieming framework, with exchange rate volatility serving as the main independent variable. The World Development Indicators provided the data used in the study. To compute exchange rate, this study applied the GARCH (1,1) model. The unit root tests employed were the Levin, Lin and Chu (2002) and Im, Pesaran and Shin (2003). The unit root tests showed that the panel data employed for the study were statistionary at level, hence the panel lest squares based on the fixed effect and random effect was adopted for the estimation. From the analysis, it was observed that exchange rate volatility exerted a negative and statistically significant on real gross domestic product and RGDP growth rate. This implied that exchange rate volatility caused a considerable decline in real GDP growth. As a result, this study recommended that governments of SSA countries formulate policies that would help to diversify their respective economies for higher domestic production that would in turn discourage high import of goods and services.

INTRODUCTION

Following the breakdown of the Bretton Woods system in 1970, there emerged a divergence in exchange rate regimes among different countries. As a result, there has been a notable increase in the adoption of floating exchange rates; however, many nations still prefer flexible intermediate systems like traditional pegs. Hence, central banks in major global economies are entrusted with the task of maintaining fixed exchange rates in countries where they are in effect. This responsibility is carried out through currency transactions aimed at stabilizing the balance between monetary supply and demand. Coping with uncertainties arising from fluctuations in exchange rates presents a challenge for these central banks in their international dealings. Both scholars and policymakers express concerns regarding exchange rate risks. The term "volatility" is utilized to describe the unpredictability and risk associated with the changing movements of exchange rates over time. These unpredictable fluctuations impact various elements such as product prices, inflation, interest rates, portfolio investments, savings, loans, and ultimately economic growth, often triggered by unforeseen shocks.

The challenging economic circumstances prevailing in developing regions like Sub-Saharan Africa (SSA) have been recognized as a significant barrier to investments and economic growth within the region. In SSA, a portion of growth-inducing investments originates from international and regional trade. The efficacy of these investments is theoretically influenced by trade policies and uncertainties, subsequently impacting the overall macroeconomic performance of countries engaged in foreign trade. Recently, one particular uncertainty that has attracted attention in financial literature is exchange rate volatility. This focus is due to the direct effect of exchange rate volatility on trade, through uncertainties and adjustment costs, as well as its indirect impact on output structure, investments, and governmental policies. The level of risk aversion among trade participants determines how this impact is transmitted to an economy. Exchange rate volatility is closely associated with a flexible exchange rate system where rates are subject to change based on market dynamics.

Exchange rate strategies in Sub-Saharan African (SSA) nations demonstrate significant disparities and have evolved over time, reflecting patterns observed in other countries. Recent research carried out by the International Monetary Fund (IMF) underscores that there is no one-size-fits-all solution

concerning exchange rate management, emphasizing that the selection of an appropriate regime (whether fixed or flexible rates) depends on the specific macroeconomic challenges faced by a country and its individual circumstances. The chosen exchange rate framework plays a pivotal role in influencing economic activities and outcomes, albeit in conjunction with other macroeconomic policies and the quality of institutional frameworks. Throughout history, SSA countries have implemented a diverse range of exchange rate systems, including fixed/pegged arrangements, flexible structures, and participation in monetary unions. The proliferation of diverse exchange rate mechanisms in Sub-Saharan Africa (SSA) has posed a significant obstacle to the attainment of overarching macroeconomic goals. Enhanced production volatility in SSA regions seems to be associated with exposure to capital flows from frontier market economies with officially designated intermediate exchange rate systems, alongside restricted adjustments in exchange rates (Guillermo, 2013).

A notable challenge arising from uncontrolled fluctuations in exchange rates, as emphasized by Banik and Roy (2020), is the susceptibility faced by economies, such as those in SSA, that heavily depend on imports. These economies often encounter economic crises characterized by exchange rate instability due to their inadequate, inferior, and outdated technological bases, where productivity activities are mainly import-focused with crucial industrial inputs procured from overseas. Consequently, exchange rate instability may result in heightened import expenses, especially post-depreciation of the local currency, leading to increased domestic goods prices, inflationary pressures, and suboptimal macroeconomic outcomes. For instance, in nations like Nigeria, a key economy in SSA heavily reliant on income from crude oil exports, the lack of substantial domestic refining capacity necessitates substantial expenditure on imported petroleum products. Unfortunately, the prevalent import-reliant framework in most SSA economies is increasingly threatened by rising import costs and falling export revenues (Carrel & Wilfried, 2021). Despite the implementation of various financial reforms and economic adjustments under diverse exchange rate mechanisms, endeavors to reinstate exchange rate stability and achieve single-digit inflation rates in the SSA region have thus far been unsuccessful.

The persistence of exchange rate volatility remains a critical concern for monetary authorities, notwithstanding the deployment of numerous measures and tactics. Carrel and Wilfried (2021),

Akinwolere (2021), in line with Ojo and Alege (2014), have highlighted that currency fluctuations emerge as a primary catalyst of macroeconomic instability in SSA economies. Similarly, findings by Mlambo (2020) suggest that enduring volatility in real exchange rates has hindered robust economic performance. Conversely, Okoro and Charles (2019), Harley (2018), and Mohammad (2017) have illustrated that the influence of exchange rate volatility on the economic performance of developing countries was not substantial. Hence, the inquiry at hand appears inconclusive due to the differing conclusions drawn from empirical studies. The number of investigations scrutinizing exchange rate volatility across Sub-Saharan African (SSA) economies is limited. This scarcity can be ascribed to the perception that exchange rate stability augurs well for the economic advancement of SSA nations. Therefore, the current study seeks to evaluate the correlation between exchange rate volatility and economic growth in forty SSA economies.

LITERATURE REVIEW

Conceptualization of Exchange Rate Volatility

Under a flexible exchange rate regime, transaction costs exhibit a tendency towards elevation in comparison to a fixed or pegged exchange rate system. The short-term fluctuations of exchange rates prove to be notably volatile and are subject to substantial influence from monetary policy, political occurrences, and shifts in expectations (Latief & Lefen, 2018). The determination of exchange rates over a prolonged period is predominantly steered by the relative costs of goods among diverse nations (Iyeli & Utting, 2017). In the extended run, the exchange rate demonstrates high volatility in contrast to the fundamental factors that underlie its determination.

The escalation in exchange rate volatility in recent times can be traced back to the abandonment of fixed exchange rates, leading to a surge in foreign exchange transactions. These transactions have exceeded the growth rate of money flows from investments and international trade. Despite the escalation in risks associated with foreign exchange trading, there has been a corresponding increase in public awareness and comprehension of the issue. Currently, global private capital flows significantly surpass trade flows, indicating that financial factors, rather than trade, predominantly influence exchange rates, especially in the short term. However, cross-border trade exerts a substantial influence on exchange rates in the long term (Eregha, 2017).

Various macroeconomic factors directly affect exchange rate fluctuations, including the supply and demand for goods, services, and investments, differing growth and inflation rates across nations, variations in relative rates of return, and other relevant variables. The adoption of floating exchange rates by numerous developing economies has been influenced by historical monetary and real disruptions. Expectations concerning current and future events play a critical role due to their significant impact on exchange rate volatility. Moreover, instances of "overshooting," where the current spot rate diverges from the long-term equilibrium calculated from a model, can result in heightened volatility. If inefficient financial markets lead to substantial exchange rate swings, it may not necessarily translate into increased transaction costs (Kanu & Nwadiubu, 2020).

A universally accepted method for measuring exchange rate volatility is lacking, reflecting a lack of consensus stemming from various factors. Consequently, theoretical frameworks do not provide definitive guidance on the most appropriate measurement approach. The selection of a measurement method is largely dependent on the scope of the analysis. For example, when concentrating on developed countries, forward markets could be utilized to assess exchange rate volatility, while this approach may not be suitable when examining a significant portion of less-developed countries. Additionally, the time horizon and the type of volatility being assessed, whether unconditional swings or unexpected changes relative to forecasted values, significantly impact the choice of a suitable measurement approach. The level of aggregation of trade flows also plays a crucial role in determining the appropriate exchange rate measure to employ. An array of methodologies exists for the computation of exchange rate volatility. Previous studies, for instance, the research conducted by Bailey, Tavlas, and Illan (1986), focused on absolute percentage alterations in exchange rates, whereas Koray and Lastrapes (1989) employed moving averages of past fluctuations. Another commonly used gauge of exchange rate volatility is the average absolute variance between the preceding forward rate and the current spot rate, which has found application in diverse research endeavors. Proponents of this measure contend that by considering forward rates that encapsulate such anticipations, market participants can anticipate exchange rate volatility effectively.

An alternative method widely acknowledged for gauging exchange rate volatility entails utilizing the moving average of the standard deviation of exchange rates. This particular approach has exhibited superior efficacy in contrast to other volatility measures. Furthermore, in contemporary times, the Autoregressive Conditional Heteroskedasticity (ARCH) and Generalized Autoregressive Heteroskedasticity (GARCH) models have garnered significant attention in scholarly literature (Mourou and Ngolali, 2021; Sugiharti, Esquivias & Setyorani, 2020).

The Theoretical Framework

The theoretical underpinning of this examination is grounded in the Mundell-Fleming model. Initially formulated by Robert Mundell and Marcus Fleming, the Mundell-Fleming model furnishes a structure for assessing monetary and fiscal policies and elucidates the operations of a minor, open economy involved in both goods and financial instrument trade at the global level. Essentially, this model expounds on the reasons for short-term fluctuations in aggregate income within an open economy.

While the traditional IS-LM model delineates a closed economy or autarky, the MFM model portrays an open economy. It illustrates the correlation between output, nominal exchange rates, and interest rates in a deregulated, open economy. Hence, considering Sub-Saharan African countries as open economies, the Mundell-Fleming model is employed in this investigation. Given that these nations' economies are relatively modest and exert little influence on global trade prices or interest rates, the assumption of perfect capital mobility is made. Research from 2004 has substantiated the relevance of the MFM as a macroeconomic policy framework. Moreover, Aizenman (2013) asserted that "the extended MFM framework continues to provide valuable insights in macroeconomic analysis," further reinforcing this assertion.

The underlying assumptions of the model are as follows:
The domestic interest rate (r) equals the world interest rate (r*); - The model depicts a small open economy with perfect capital mobility; - It assumes a fixed price level.

The Mundell-Fleming model's central prognosis is that an economy's behavior is predominantly influenced by the type of exchange rate system it opts for, whether fixed or variable. The IS Curve for Open Economy: The goods and services market in the Mundell-Fleming model is represented by the following equation:

The utilization of each term in its conventional context is crucial. The global interest rate, denoted as r*, plays a pivotal role in determining investment when r = r*, while the exchange rate, e, influences net exports (NX), representing the price of foreign currency in domestic currency, alongside Y denoting output growth.

Empirical Investigation

Koroma, Jalloh, and Squire (2023) scrutinized the impact of exchange rate fluctuations on the economic growth of Sierra Leone. The study period spanned 39 years, from 1980 to 2018. The analysis unveiled a notable positive correlation between economic growth in Sierra Leone and fluctuations in exchange rates, particularly the depreciation of the Leones. Results indicated that exchange rate variations could either positively or negatively affect a nation's economic growth. Data analysis was carried out using the ordinary least squares method, drawing conclusions from regression analysis.

Eklou (2023) conducted a study on the influence of Dollar exchange rate fluctuations on the productivity of firms in emerging markets. Data from 16 emerging economies between 1998 and 2019 revealed how Dollar exchange rate volatility impedes corporate productivity. The research highlighted the impact on countries with limited financial development, significant Dollar invoicing, strong trade relations with the US, extensive collective bargaining coverage, and open capital accounts. Foreign Exchange Interventions (FXI) were found to counteract the negative impact on firm productivity through policy efficacy assessment.

Ramoni-Perrazi and Romero (2022) assessed the effects of exchange rate volatility on economic

growth across 194 countries from 1995 to 2019. Dynamic panel data models were employed, considering variables like financial development, economic openness, investment, government spending, educational attainment expectations, and exchange rate volatility estimated using GARCH models. Countries were categorized based on government corruption levels, with estimates generated through the System Generalized Method of Moments and Difference. Results consistently indicated a significant adverse impact of exchange rate volatility on economic growth, especially in less mature financial sectors.

To explore the influence of exchange rate volatility on economic advancement, Fofonah (2022) conducted a study encompassing twelve West African countries: The Gambia, Ghana, Cote d'Ivoire, Mali, Niger, Nigeria, Senegal, Togo, Benin, Burkina Faso, Guinea Bissau, and Sierra Leone. Random effects and the two-step discrepancy approach were employed, utilizing the Generalized Method of Moments (GMM) for estimation. The evaluation of lagged exchange rate variations using the "Ad hoc method" confirmed the reliability of the random-effects model. Findings suggested that as the financial sector of each West African country progresses, the constraining effect of real effective exchange rate volatility on economic growth diminishes. Between 2000 and 2018, Olamide, Ogujiuba, and Maredza (2022) undertook an investigation concerning the influence of exchange rate volatility on the correlation between inflation and growth within the Southern African Development Community. The research utilized three principal analytical techniques, specifically Pooled Mean Group (PMG), Generalized Moments (GMM), and Dynamic Fixed Effect (DFE). Moreover, exchange rate volatility was introduced through GARCH (1, 1). The study unveiled a connection between the sluggish progress of the economy in the area and the volatility in exchange rates and inflation. Subsequent examinations demonstrated that the negative repercussions of exchange rate volatility on inflation had an adverse impact on the economic growth of the region: a stronger relationship between inflation and growth resulted in heightened instability in the exchange rate.

In Nigeria, covering the years from 1986 to 2019, Atayi, Ibukun, Abdulsallam, and Jolumo (2021) explored the association between exchange rate volatility and macroeconomic performance. The

investigation employed two methodologies: the boundaries co-integration test and ARDL. The outcomes displayed a negative correlation in earlier periods, while in recent times, a positive connection between the exchange rate and GDP was observed. In accordance with prior expectations, long-term data implied an unfavorable relationship. Over time, interest rates and GDP displayed a positive association.

Akinwolere (2021) critically analyzed the impact of exchange rate volatility on the economic growth of Nigeria during the period from 1986 to 2019. The study utilized the VECM methodology to investigate the effects of exchange rate fluctuations on selected macroeconomic variables using time series data. The results indicated that fluctuations in exchange rates had a positive effect on inflation, unemployment, and trade balance, exerting a notable influence on economic growth. However, these fluctuations had a negative impact on investment and overall economic growth.

From 1986Q1 to 2019Q4, Bello, Olayungbo, and Folorunsho (2021) assessed the asymmetric relationship between Nigeria's macroeconomic performance and exchange rate volatility. They employed the nonlinear GARCH model for their analysis. The nonlinear GARCH models were influenced by the ARCH effect, suggesting consistent volatility throughout the study period. Consequently, the outcomes highlighted a positive correlation between exchange rate volatility and trade balance, industrial output, and inflation. Positive news often outweighed negative news in the foreign exchange market.

Iheanachor and Ozegbe (2021) scrutinized the impact of ongoing fluctuations in exchange rates on Nigeria's economic performance. The research aimed to comprehend why the endeavors of Nigeria's monetary authorities to achieve internal and external equilibrium had not yielded substantial advantages. By utilizing the ARDL technique, the study explored the short- and long-term implications of exchange rate fluctuations on economic growth using yearly time series data from 1986 to 2019. The findings emphasized that excessive fluctuations in exchange rates had adverse consequences for Nigeria's economic expansion.

Mlambo (2020) carried out an assessment regarding the impact of currency exchange rate fluctuations on the industrial performance of the states within the SACU. Between 1995 and 2016, the research employed the panel group FMOLS and PMG methodologies. The findings indicated an adverse relationship between the manufacturing sector's performance and variables such as the exchange rate, imports, and Foreign Direct Investment (FDI). Additionally, it was noted that the success of manufacturing exhibited a positive connection with inflation levels and exports.

Morina, Hysa, Ergun, Panait, and Voica (2020) examined the repercussions of exchange rate volatility on the economic growth of Central and Eastern European (CEE) nations. This investigation delved into three distinct channels through which exchange rate volatility could impact economic growth, utilizing various measures of volatility. By analyzing yearly data from fourteen (14) CEE countries spanning from 2002 to 2018, the study aimed to discern the nature and extent of growth-related consequences stemming from such volatility. The empirical results, derived from fixed effects estimates for panel data, unveiled a substantial adverse effect of exchange rate volatility on the real economy.

Adegboyo (2019) delved into the interconnections between exchange rate fluctuations and macroeconomic aggregates in Nigeria from 1986 to 2017. By employing Autoregressive Distributed Lag (ARDL) and Granger causality analyses, the study depicted the dynamic and directional links among the variables in the model. The outcomes emphasized that while terms of trade (TOT) had a slight positive impact on exchange rate fluctuations, the behaviors of Real Gross Domestic Product (RGDP) and Foreign Direct Investment (FDI) significantly influenced variations in EXR. Noteworthy is the calculation of the Estimated Coefficient of the Error Correction Model (ECM) as -0.704469, indicating that approximately 70.45 percent of any imbalance in EXR variations was rectified within a single period.

Adeniyi and Olasunkanmi (2019) estimated the effects of exchange rate volatility on economic growth in Nigeria. Through the utilization of ARDL cointegration and Error Correction Model (ECM) frameworks, the study aimed to tackle this specific objective. The results pointed to the

presence of cointegration among the variables, with a notable impact of exports on Gross Domestic Product (GDP), while imports displayed insignificance in both short and long-term perspectives. Furthermore, the study established an insignificant positive association between exchange rate volatility and economic growth in Nigeria.

Ozcelebi (2018) applied Panel Vector Autoregression (PVAR) models to evaluate the impacts of exchange rate volatility on industrial production, Consumer Price Index (CPI) inflation, short-term interest rates, and stock returns across ten (10) OECD countries. The analysis of Variance Decompositions (VDCs) implied that fluctuations in interest rates could be impacted by factors linked to exchange rate volatility. Therefore, when considering scenarios of Uncovered Interest Rate Parity (UIP), it is essential to account for additional macroeconomic variables.

Furthermore, the Impulse Response Functions (IRFs) of the research unveiled by Barguellil, Ben-Salha, and Zmami (2018) using the generalized method of moments (GMM) estimators, indicated the potential of exchange rate volatility to improve liquidity conditions in the money market. This enhancement could lead to a rise in actual economic activities as investors shift their capital from currency markets to money markets.

In a study conducted by Iyeli and Utting (2017) on the impact of exchange rate volatility on the economic growth of Nigeria from 1970 to 2011, the dependent variable considered was Real GDP. The study utilized data from the Central Bank of Nigeria (CBN) Statistical Bulletin and applied Johansen cointegration techniques to evaluate the short- and long-term effects of the independent variables including exchange rate (EXR), oil revenue (OREV), balance of payments (BOP), and inflation (INF). The results showed that all variables were stationary based on unit root tests. The simplified model indicated a positive association between OREV, EXR, and GDP. Furthermore, the analysis revealed two equations significant at the 5% level in both trace and Max – Eigen statistics, implying a positive contribution of EXR volatility and OREV to GDP over an extended period.

Sanidas and Hunegnaw (2017) employed panel data from seventeen (17) non-Euro OECD economies and seventeen (17) SSA nations spanning from 1995 to 2013 in their study. The research illustrated that policymakers could utilize exchange rate fluctuations to improve trade balances and boost real output. Despite variations, similarities were noted in the importance of exchange rate impacts and income effects (both domestic and external GDP) on direct trade balances, particularly emphasizing a stronger influence in SSA compared to the OECD group.

Alagidede and Ibrahim (2016) investigated the factors influencing exchange rate volatility and economic growth. Their results suggested that while exchange rate shocks tended to revert to the mean, misalignments corrected slowly, resulting in short-term disruptions as economic agents reassessed their investment and consumption decisions. A considerable portion of real exchange rate shocks were internally driven, with the remaining attributed to factors such as terms of trade, GDP shocks, government expenditure, and fluctuations in money supply. The study emphasized the adverse consequences of excessive volatility on economic growth.

Ubah (2015) investigated the repercussions of fluctuations in exchange rates on the economic development of Nigeria by examining annual data from 1980 to 2012. The analysis involved conducting Cointegration following the Augmented Dickey-Fuller (ADF) test to assess stationarity. The results pointed out that all variables were integrated at the first order, denoted as I(1). Further validation of co-integration was done through supplementary analysis. By utilizing the GARCH methodology, the association between exchange rate volatility and Gross Domestic Product (GDP) was quantified. The research unveiled a significant immediate effect of exchange rate volatility on GDP, alongside a prolonged adverse correlation between the two variables.

Ojo and Alege (2014) delved into the impacts of fluctuations in exchange rates on output and other determinants of exchange rates. A panel data set encompassing forty countries from Sub-Saharan Africa (SSA) between 1995 and 2007 was employed. The study utilized dynamic Generalized Method of Moments (GMM) techniques. To evaluate the enduring connection between exchange

rates and macroeconomic elements in SSA nations, panel cointegration characteristics were scrutinized. The panel Granger causality test affirmed the mutual correlations between exchange rate volatility and GDP.

Azeez, Kolapo, and Ajayi (2012) scrutinized the influence of exchange rate volatility on the macroeconomic dynamics of Nigeria from 1986 to 2010. Real Gross Domestic Product (GDP) was considered the dependent variable, while the independent variables comprised exchange rate (EXR), oil revenue (OREV), and balance of payments (BOP). Johansen co-integration estimation and Ordinary Least Squares (OLS) were deployed to evaluate the short and long-term impacts. Unit root tests substantiated the stationarity of all variables. The OLS outcomes illustrated a negative correlation between BOP and GDP, whereas OREV and EXR displayed positive correlations.

Vieira and MacDonald (2012) probed the effects of real exchange rate misalignment on long-term growth across ninety countries utilizing time series data from 1980 to 2004. They computed real exchange rate misalignment based on an equilibrium estimation derived from a panel data model. Panel cointegration techniques were employed to provide alternative misalignment assessments. The study deduced that a more devalued (appreciated) real exchange rate benefits (harms) long-term growth. Results from System GMM panel growth models consistently manifested positive coefficients for real exchange rate misalignment across various specifications and samples.

The economic growth of Iran during the flexible exchange rate system period (1988:Q1-2007:Q4) was assessed by Sanginabadi and Heidari (2012). A prevalent approach to gauge exchange rate volatility is by formulating a time-varying conditional variance of the exchange rate utilizing the GARCH models. Moreover, they tackled the level relationship employing the ARDL bounds test technique. The outcomes revealed a significant correlation between Iranian growth volume and real exchange rate volatility. As per the long-term results of the ARDL model, exchange rate volatility detrimentally affects economic growth. The ECM estimate suggested that approximately 22% of the disequilibria from preceding period shocks converge back to the long-term equilibrium

in the current era.

Knowledge Gap

The impact of exchange rate volatility on economic growth has been extensively researched. Numerous studies have focused on how exchange rate dynamics affect economic growth, particularly in single-country analyses, with limited studies on a panel study of SSA. To address this gap, this current research developed a model illustrating the impact of exchange rate volatility on the macroeconomic performance of SSA economies.

Most of the reviewed studies did not encompass the most recent data, necessitating an examination of annual time series data from 2000 to 2022 to reflect the contemporary reality of exchange rate fluctuations on SSA's economic growth. The conclusion of this study will provide insights into the way forward regarding these issues.

METHODOLOGY

Research Design

An essential aspect of research quality lies in a profound comprehension of the research design. Research design encompasses the methodologies and procedures employed in scientific research. As described by Onwumere (2009), a research design serves as a blueprint guiding researchers in their analyses and investigations. This study utilized an ex post facto research methodology to explore how exchange rate volatility impacts the macroeconomic performance of SSA countries using previously released data. Ex post facto study, also known as after-the-fact research, involves empirical analysis of a phenomenon post-occurrence without interference from the researcher.

Nature and Sources of Data

The annual historical data utilized in this study was sourced from secondary sources, with real gross domestic product being the primary focus while other variables retained their nominal forms. The adjustment of GDP to its real value indicates inflation correction before analysis. Real GDP

is favored over nominal GDP for tracking macroeconomic performance trends over time. Economic experts rely on real GDP for studying macroeconomic trends as it adjusts for inflation impacts. Additionally, GDP per capita was considered as a dependent variable to assess the differential effects of exchange rates on real GDP and individual economic production values.

Model Specification

Building upon the research conducted by Jeelani (2018, the present study formulated its model. The model proposed by Jeelani (2018) was explicitly described in equation (3.1): $Y_T = F(EXRVOL)_T$ (3.1)

In this equation, 'Y' denotes the output, while 'EXRVOL' represents exchange rate volatility. By integrating the macroeconomic principles of the Mundell-Fleming framework, modifications were made to the model developed by Jeelani (2018. This integration suggested that variables such as GDP, interest rate, exchange rate, inflation (price level), trade openness, and other similar factors could be interconnected, resulting in the formulation of equation (3.2): $Y_T = F(EXRVOL*z)_T$ (3.2)

Here, refers to the output, represents exchange rate volatility, and signifies macroeconomic variables.

Consequently, equation (3.2) was translated into an econometric representation as equation (3.3):
$Y_T = F(EXRVOL, TOT, INT)$ (3.3)
In this equation, INT stands for the interest rate, and TOT represents the terms of trade, reflecting trade openness.

The macroeconomic theory of the Mundell-Fleming framework posits implicit associations between variables such as real GDP, inflation (price level), exchange rate, and interest rate (Aizenman, 2013; Barguellil, Ben-Salha & Zmami, 2018). TOT and INT were included in the model as moderating variables (control variables). Therefore, guided by the assumptions of the

Mundell-Fleming framework presented in equation (3.3), the functional form of the model was specified as follows: RGDP =F (EXRVOL,TOT, INT)

(3.4)

The econometric model configuration of this study is demonstrated in equation (3.5):

(3.5)

Thus, equation 3.5 was divided into five distinct models to address the study's objectives. Due to the skewness and non-normal distribution of the data, a logarithmic transformation was applied to the dataset. Through this transformation, highly skewed data can be normalized. Therefore, summarizing the aforementioned equations in an econometric manner, the equations were organized in accordance with the specified hypotheses:

Hypothesis: The impact of exchange rate volatility on economic growth in Sub-Saharan African nations is insignifi representedt:

(3.6)

Equation 3.6 postulates that exchange rate volatility influences economic output (measured by RGDP). This assertion aligns with Morina et al.'s (2020) findings in developing countries. Fluctuations in the exchange rate are expected to lead to corresponding fluctuations in economic output. The impact of exchange rate volatility on real GDP can be either positive or negative. For example, an upward trend in the exchange rate promotes exports and deters imports, thereby stimulating domestic economic output. Conversely, a downward trend in the exchange rate may contract the economy. Therefore, continuous volatility is anticipated to negatively affect real GDP.Furthermore, to have a robust analysis on economic growth, this study also estimated a model that captured the impact of exchange rate volatility on the growth rate of RGDP. This model was

added in line with the study of Iyeli and Utting (2017) who had stated that exchange rate actually influences the growth rate of RGDP as the annual growth rate of RGDP is a better measure of economic growth of a country. Hence, equation (3.7) was specified to see whether the results would differ:

The classification of model variables involves categorizing them into dependent variables (response) and explanatory variables (independent variables).

The dependent variable examined in this research was real GDP, which quantifies the value of output in multiple years by adjusting for inflation. Real GDP serves as a reliable proxy for economic output, offering a more precise depiction of the economy. It represents the monetary value of goods and services generated within an economy over a specific period, irrespective of the producers' nationality, after adjusting for inflation. Economists prefer using real GDP to assess growth instead of nominal GDP or GNP, as the latter needs annual inflation adjustments. Consequently, nominal GDP, a monetary metric, indicates the overall output level post-adjustment.

Exchange rate volatility (EXRVOL) characterizes fluctuations in exchange rates over time, with volatility clustering being a common trait in exchange rate variations. Given this volatility pattern, the relationship between economic growth and volatility may vary across nations with differing volatility levels. The measurement of exchange rate volatility employed the GARCH model.

Terms of trade (TOT) signify the ratio of export prices to import prices, determining the import quantity achievable per unit of exports. A rise in terms of trade implies heightened interest in a nation's exports, leading to increased export revenue and a subsequent surge in demand for the nation's currency, elevating its value.

Interest rate (INT) fluctuations can impact a nation's currency value, with a continuous interest rate hike resulting in a reduced money supply and an associated long-term currency appreciation. Conversely, a decrease in interest rates stimulates the money supply, influencing the currency

value in the opposite direction. Immediate exchange rate and interest rate changes exceeding their long-term reactions are termed "overshoots," diminishing the currency's demand and potentially decreasing its value in the exchange rate markets.

The data analysis techniques in this study involved employing Levin-Lin and Chu (2002) and Im-Pesaran and Shin (2003) panel unit root tests. Initially, both unit-root tests were conducted to analyze the data. Despite criticisms regarding the homogeneity assumption, the Levin-Lin and Chu panel unit-root test was used alongside the Im, Pesaran, and Shin (2003) heterogeneous panel unit-root test to address individual unit-root test concerns. The utilization of two distinct panel unit-root tests aimed to ensure the study's credibility in conducting a reliable unit-root test.

The assessment of exchange rate volatility in this research was based on the Generalized Autoregressive Heteroskedasticity (GARCH) conditional variance, evaluated using specific equations.

The symbols represent the logarithms of the nominal and real exchange rates and the conditional variance, respectively. The latter symbolizes the currency rate's volatility. Equations (1) and (2) were utilized for estimating the exchange rate volatility indexes through the GARCH (1,1) model.

Panel regression

Utilizing panel data for regression is a powerful method for addressing the potential bias of unknown independent variables impacting a dependent variable in traditional linear regression models. Panel data combines cross-sectional and time-series data to capture observations of multiple items and related variables at a specific moment (cross-sectional data) and records one object over an extended period (time-series data). This model, known as panel data, integrates characteristics from both data types.In this research, the model was estimated using various forms of panel regression:

Pooled OLS: This approach, also known as simple OLS (Ordinary Least Squares), is applied to panel data and disregards individual and time-specific characteristics to focus solely on variable dependencies.

Fixed-Effects (FE) Model: The FE-model considers the individual impacts of unobserved variables as constant over time.

Random-Effects (RE) Model: The RE-model treats the individual impacts of unobserved variables as random over time, allowing for both inter- and intra-individual dependencies.

The choice between FE and RE is determined by conducting the Hausman-Test, which assesses endogeneity. The test's null hypothesis is that the covariance between coefficient estimates and alpha is zero (Hausman & Taylor, 1981). If confirmed, RE is favored over FE; otherwise, the FE-model is more appropriate.

ANALYSIS AND DISCUSSIONS

Trend Analysis of the Data

From the raw data presented in appendix 1, the average values of the variables were computed as presented in Table 4.1 and further plotted in different figures to display their trends.

Table 4.1: Average values of the variables for each country

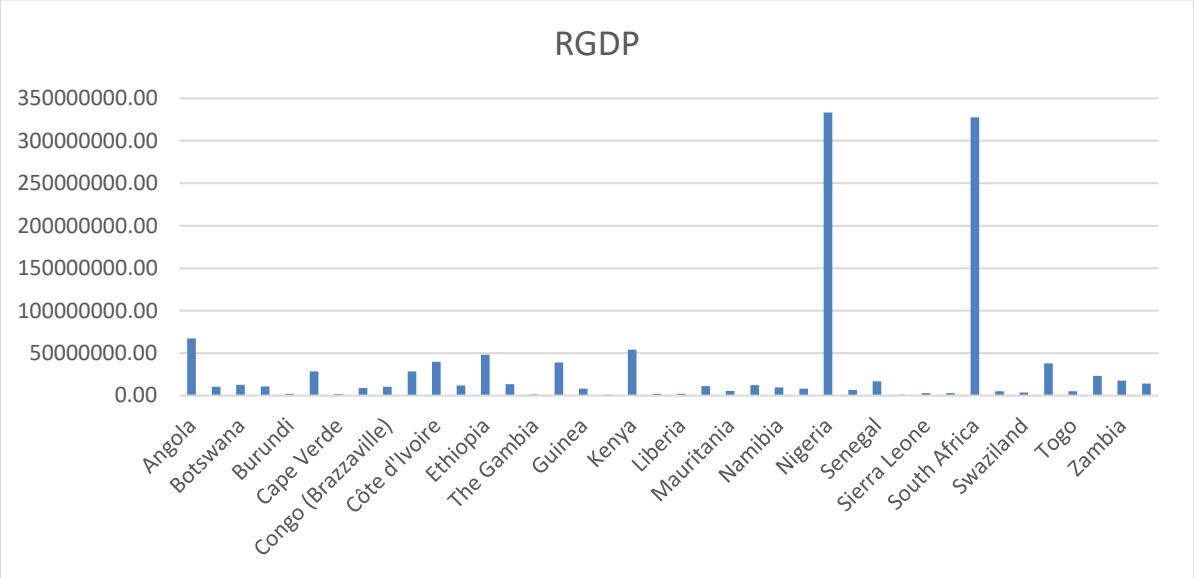
COUNTRY	RGDP	EXR	TOT	INT
Angola	67,423,286.78	167.22	175.11	17.47
Benin	10,291,217.85	557.01	117.57	5.69
Botswana	12,537,554.69	7.99	88.56	11.44
Burkina Faso	10,814,346.57	557.05	115.83	23.38
Burundi	1,973,301.13	1,383.43	132.18	15.34
Cameroon	28,667,840.10	557.05	137.82	7.18
Cape Verde	1,617,868.88	93.69	102.86	10.51
Chad	8,938,218.42	557.05	159.17	16.41
Congo (Br.)	10,545,903.62	557.05	174.42	23.61
Congo (DR)	28,518,689.51	917.72	122.14	34.51
Côte d'Ivoire	39,641,410.89	557.05	148.19	5.49
Equ. Guinea	12,017,736.50	557.05	171.11	19.25

Ethiopia	48,042,300.82	18.72	126.48	14.61
Gabon	13,435,118.21	557.05	169.91	15.11
The Gambia	1,339,981.84	34.49	102.67	27.61
Ghana	39,053,440.88	2.61	166.04	14.25
Guinea	8,083,515.09	6,120.51	108.71	13.62
Guinea-Bissau	957,874.69	557.05	91.31	8.04
Kenya	54,198,549.75	87.70	94.92	15.21
Lesotho	1,945,556.48	10.28	83.29	12.22
Liberia	2,268,958.42	89.79	127.25	14.56
Mali	11,220,442.20	557.05	145.91	6.34
Mauritania	5,541,698.73	30.13	135.21	18.68
Mozambique	12,128,783.47	37.97	98.33	19.58
Namibia	9,664,768.72	10.29	121.85	10.69
Niger	8,300,378.69	557.05	159.26	7.35
Nigeria	333,292,806.05	199.00	151.20	17.39
Rwanda	6,497,116.79	668.82	160.50	16.56
Senegal	16,630,556.01	557.05	105.58	5.24
Seychelles	1,138,469.19	10.81	84.74	7.13
Sierra Leone	2,945,530.95	5.13	66.66	20.69
Somalia	3,009,611.67	13,094.72	98.36	35.59
South Africa	327,816,186.26	10.28	133.01	10.92
Sudan	5,265,166.59	47.98	186.50	16.24
Swaziland	3,680,882.52	10.28	109.24	10.80
Tanzania	37,904,144.97	1,594.89	137.88	16.81
Togo	4,982,040.86	557.05	97.90	5.06
Uganda	23,091,795.51	2,571.65	108.87	21.21
Zambia	17,545,623.32	7.61	159.40	23.00
Zimbabwe	14,278,441.69	1,480.90	105.56	21.87

Source: Author' computation using data from World Development Indicators

Over the period of study, Figure 4.1 shows that Nigeria had the highest RGDP followed by South Africa. This indicates that Nigeria and South Africa are the two largest economies in SSA region. Both countries, on average between 2000 and 2022 had a RGDP of $333,292,806.05 and $327,816,186.26, respectively. Following Nigeria and South Africa was Angola with a RGDP worth of $67,423,286.78. Kenya came behind Angola with an RGDP of $54,198,549.75. The other countries' RGDP were below $50,000,000 with countries like Cameroon, Cote D'Ivoire, Ethiopia, Ghana and Tanzania showing signs of potential productivity as their respective RGDP were quite moderate. This shows that most SSA economies are experiencing low production.

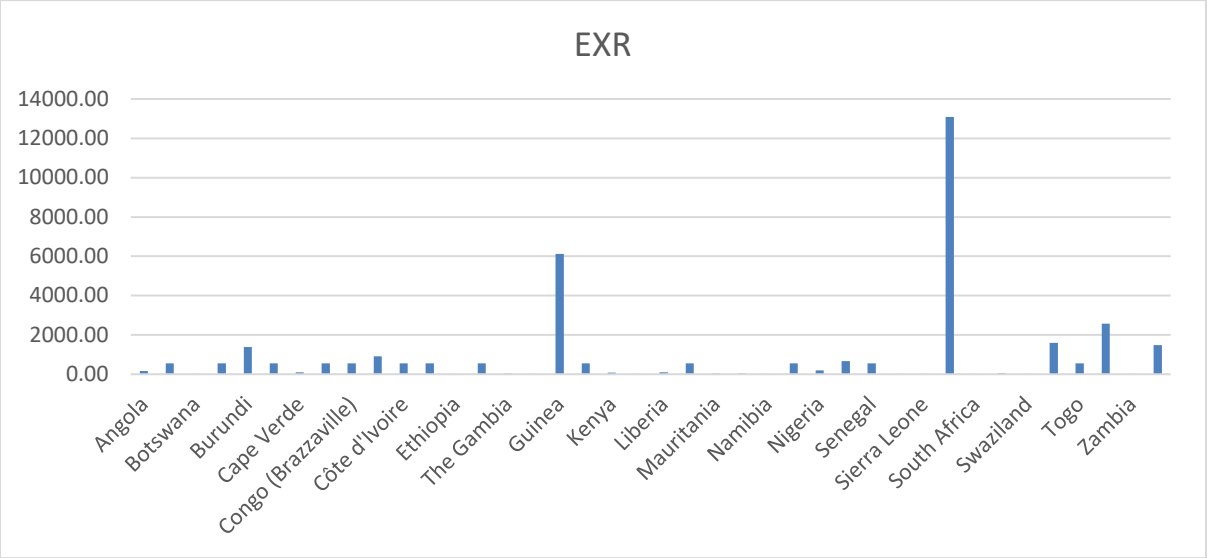
Figure 4.1: Real gross domestic product (RGDP)



Source: Researcher's computations using MS Excel

From Figure 4.2, it was observed that Somalia exhibited the highest mean exchange rate of 13,094.72 to $1, succeeded by Guinea at a rate of 6,120.51 to $1, Uganda at 2,571.65 to $1, Zimbabwe at 1480.90, and Tanzania at 1,594.89 to $1. Furthermore, other nations such as Nigeria, South Africa, Angola, Botswana, Cape Verde, Ethiopia, The Gambia, Ghana, Kenya, Lesotho, and Zambia have experienced a substantial increase in exchange rates. This phenomenon signifies that the currencies of numerous Sub-Saharan African (SSA) countries are depreciating in comparison to the US dollar. Such devaluation could be attributed to excessive imports and insufficient exports.

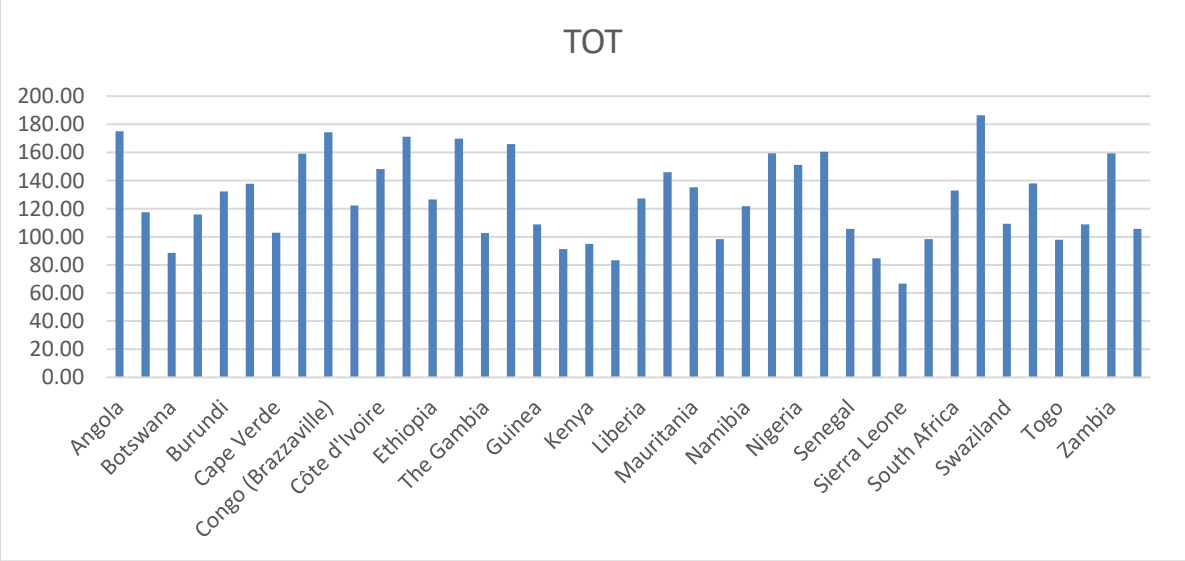
Figure 4.2: Exchange rate (EXR)



Source: Researcher's computations using MS Excel

The total trade balance for the various SSA countries surpasses the benchmark of 100 per cent. The Total Trade Balance (TOT) is determined by the ratio of import prices to export prices, indicating the quantity of imported goods or commodities that an economy can purchase per unit of exported goods or commodities. It has been noted that TOTs exceeding 100 are on the rise, whereas those below 100 are experiencing a decline. This suggests that although the TOT of certain SSA countries is generally improving, those of Botswana, Guinea-Bissau, Kenya, Lesotho, Mozambique, Seychelles, Sierra Leone, and Togo are deteriorating.

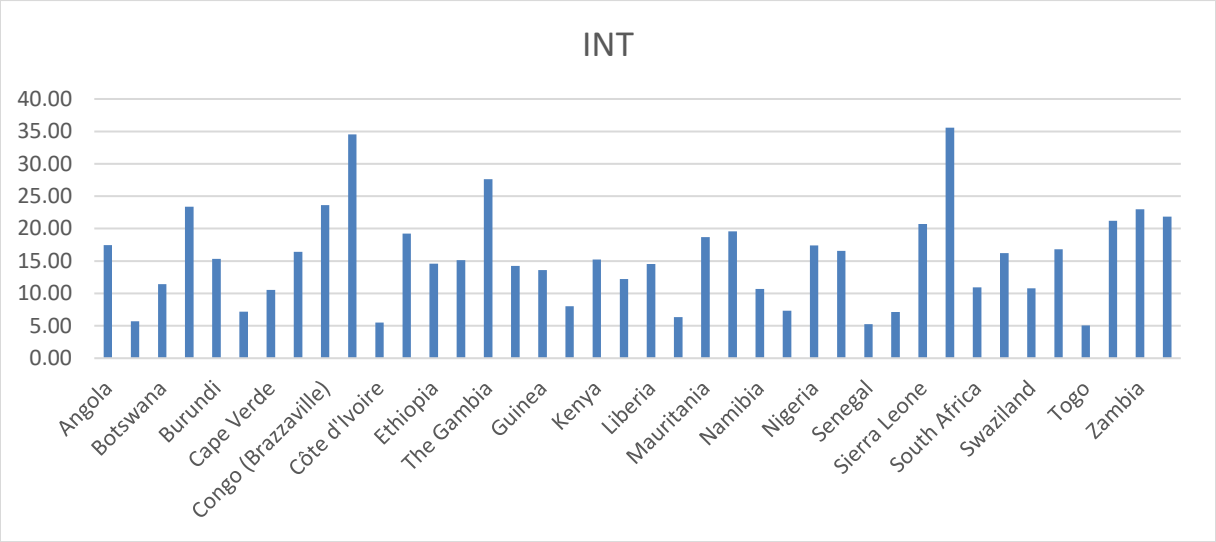
Figure 4.3: Terms of trade (TOT)



Source: Researcher's computations using MS Excel

Figure 4.4 illustrates that the mean interest rate on loans within the SSA nations is notably elevated. The data pertaining to INT consistently exceeded 5 percent across all the regions. Nevertheless, specific countries like Benin (5.69 percent), Cote D'Ivoire (5.49 percent), Mali (6.34 percent), Senegal (5.24 percent), and Togo (5.06 percent) demonstrated comparably lower figures. This observation highlights the significant inflationary tendencies within SSA, as the heightened lending costs are transferred to consumers, leading to increased prices for goods and subsequently diminishing the buying power of the local currency vis-à-vis the dollar, thereby resulting in a heightened exchange rate.

Figure 4.4: Interest rate (INT)



Source: Researcher's computations using MS Excel

Summary statistics

The study carried out a descriptive analysis of raw data (untreated data) panel data of the selected SSA countries. The outcome of the descriptive statistic is presented in Table 4.2:

Table 4.2: Descriptive statistic of data

	RGDP	EXR	TOT	INT
Mean	32365840	898.9052	127.0376	15.42218
Median	10222119	470.2900	115.1050	14.80500
Maximum	5.74E+08	31558.91	260.7300	131.8100
Minimum	371095.5	0.540000	21.40000	1.470000
Std. Dev.	77135293	2895.088	41.05513	9.437829
Skewness	4.358257	7.455310	0.840061	3.168834
Kurtosis	22.51964	65.03862	3.314899	30.20240

Jarque-Bera	17518.11	156059.5	112.0089	29905.24
Probability	0.000000	0.000000	0.000000	0.000000
Sum	2.98E+10	826992.7	116874.6	14188.41
Sum Sq. Dev.	5.47E+18	7.70E+09	1548996.	81857.73
Observations	920	920	920	920

Source: Researcher's computations using EViews

Table 4.2 presents the measure of central tendency as measured by the mean values. The mean value of real gross domestic product (RGDP) was $32,365,840 with a mid-point of $10,222,119 as measured by the median. The maximum value of $574,183,825.6 was recorded in 2014 for Nigeria. The lowest RGDP was $371,095.5 which was recorded in 2000 for Guinea-Bissau. The standard deviation of which measures the risk was 77135293, indicating that data posits are far from the mean. The skewness value of 4.358257 is greater than one, implying that the RGDP data is extremely skewed. The Kurtosis value of 22.51964 > 3 suggests that the data for RGDP is highly peaked (leptokurtic). With a Jarque-Bera probability value of 0, the distribution of the RGDP data was adjudged to be abnormally distributed. Hence, with the RGDP data being extremely skewed, highly peaked and non-normally distributed, its log transformation was taken for the regression analysis.

The exchange rate (EXR), on average was 898.9052 (domestic currency) to $1, indicating that the currency of most SSA countries are weak. The EXR ranged from 0.540000 (minimum) to 31,558.91 (maximum). The lowest EXR as indicated by the minimum value was associated with Ghana in 2000 while the highest EXR was linked to Somalia in 2009. The risk factor of 2895.088 as indicated by the standard deviation shows a large dispersion from the mean, meaning that SSA countries experienced high exchange rate risk within the period under consideration. EXR has a skewness of 7.455310, implying an unsymmetrical distribution while the Kurtosis of 65.03862 suggests a highly peaked distribution. With a probability value of 0.0000, the Jarque-Bera indicates that the normal distribution null hypothesis is rejected. Therefore, while using the model for exchange rate volatility, a natural log transformation was performed due to the non-symmetrical and highly peaked data associated with EXR.

The terms of trade (TOT) emerged with an average value of 127.0376 per cent. The minimum and maximum values shows that TOT lied between 21.40000 per cent and 260.7300 per cent. The

lowest TOT as indicated by the minimum value was obtained for Togo in 2005 while the highest value as indicated by the maximum value was obtained for Sudan in 2022. The standard deviation of 41.05513 shows a considerable deviation from the mean. With a skewness of 0.840061 < 1, the TOT was likewise determined to be symmetrical. Its Kurtosis of 3.314899 > 3 points to a leptokurtic distribution, and its Jarque-Bera probability value of 0.000 points to a non-normal distribution. For this reason, the analysis employed the logarithmic transformation of the TOT data.

Regarding interest rate (INT), an average value of 15.42218 per cent was obtained. The maximum value of 131.8100 was linked to Zimbabwe in 2022. The minimum of 1.470000 per cent is associated with Cameroon in 2018. The risk factor as denoted by the standard deviation was 9.437829. A skewness of 3.168834 > 1 is indicative of a non-symmetrical distributed dataset. The Kurtosis of 30.20240 > 3 is indicative of a highly peaked (leptokurtic) distribution. The Jarque-Bera probability value of 0.0000 suggests a non-normally distributed dataset. Hence, the data was treated by applying a natural logarithmic transformation of the data.

Constructing Exchange Rate Volatility Series

The exchange rate volatility series were generated using the GARCH (1,1) model. The predicted (fitted) values were obtained for the estimated GARCH(1,1) model as the volatility series. Table 4.3 presents the results of the GARCH(1,1) model.

Table 4.3: GARCH (1,1) model result

Dependent Variable: LNEXRVOL
Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)
Date: 10/30/23 Time: 18:10
Sample (adjusted): 2 920
Included observations: 919 after adjustments
Failure to improve likelihood (non-zero gradients) after 39 iterations
Coefficient covariance computed using outer product of gradients
Presample variance: backcast (parameter = 0.7)
GARCH = C(3) + C(4)*RESID(-1)^2 + C(5)*GARCH(-1)

Variable	Coefficient	Std. Error	z-Statistic	Prob.
LNEXRVOL(-1)	0.943689	0.018648	50.60499	0.0000
C	0.321062	0.092413	3.474211	0.0005
Variance Equation				
C	0.233604	0.096279	2.426324	0.0153

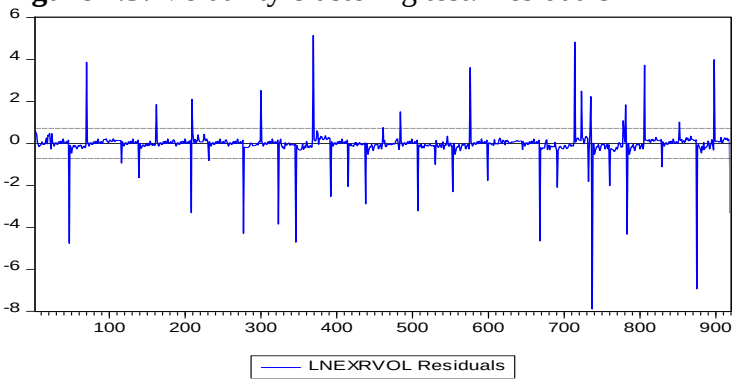
RESID(-1)^2 α	0.008573	0.000414	20.68773	0.0000
GARCH(-1) β	0.837100	0.142107	5.890626	0.0000
α + β	0.845673	-	-	-

R-squared	0.895959	Mean dependent var	4.947667
Adjusted R-squared	0.895845	S.D. dependent var	2.221904
S.E. of regression	0.717076	Akaike info criterion	2.166228
Sum squared resid	471.5197	Schwarz criterion	2.192470
Log likelihood	-990.3818	Hannan-Quinn criter.	2.176243
Durbin-Watson stat	1.980865		

Source: Researcher's computations using EViews

The mean equation's result, as shown in Table 4.3, indicates that the exchange rate immediate past value has a positive and considerable impact on its current value. The presence of volatility clustering is implied by the variance equation's conclusion, which shows that the ARCH term is statistically significant. Furthermore, it demonstrates the statistical significance of the GARCH term, which suggests that exchange rate volatility persists over the long run. The fact that the total of the GARCH and ARCH terms (0.845673) approaches to unity indicates that there is a considerable degree of volatility in real effective exchange rates.

Figure 4.5: Volatility clustering test: Residuals



Source: Author's computations using EViews

In this study, large swings in the exchange rate that result in clusters or groups are what define the financial phenomena known as volatility clustering. The primary cause of this clustering is the foreign exchange market's extraordinary volatility. Figure 4.5 shows that the exchange rate in SSA is quite volatile.

Correlation Matrix

Having treated the data by taking their natural log, a correlation analysis was carried to ascertain the linear association with them and to detect the presence of multicollinearity, if any, among the independent variables. The result of the correlation analysis is presented in Table 4.4.

Table 4.4: Correlation matrix

	LNRGDP	LNEXRVOL	LNTOT	LNINT
LNRGDP	1	-0.03501	0.491102	-0.04529
LNEXRVOL	-0.03501	1	0.050913	-0.04294
LNTOT	0.491102	0.050913	1	0.00331
LNINT	-0.04529	-0.04294	0.00331	1

Source: Researcher's computations using EViews

The correlation matrix, which shows if a linear relationship can be created between the variables employed in the model, is a test of the linear association of the variables rather than a test of influence or causation. The results showed that there is a negative correlation between RGDP and exchange rate volatility (EXRVOL). That is, the economy grows more slowly the more volatile the exchange rate is. Also, the extent of correlation among the explanatory variables are high as the correlation coefficients are less than 0.5, implying that the natural log of the independent variables are not correlated (no multicollinearity).

Panel Regression Estimation

For selecting the best model of this data, the Hausman test was used to compare and choose between the results of the random-effects and fixed-effects, by testing the following hypothesis:

Ho: Random effects model is the appropriate model.

Ha_1: The fixed effects model is the appropriate model.

The results of the Hausman tests are summarized in Table 4.5.

Table 4.5: Hausman tests

Hypothesis	Chi-Sq. Statistic	Prob.	Decision
One	12.480378	0.0059***	Fixed effect
	16.830263	0.0008***	Fixed effect

Source: Researcher's computations using EViews

In Table 4.5, Hausman test results indicate that the fixed effect model is more appropriate in explaining the relationship among the given first, fourth and fifth models as the null hypothesis of random effects is rejected. It shows that differences among firms influence the relationships between the variables considered. The prob. values were 0.0059 < 0.05, 0.0341 < 0.05 and 0.0130 < 0.05 for the first, fourth and fifth models, respectively. Thus, for the aforementioned models, the study discussed in detail the results of fixed effect model only.

For the second and third models, the random effects model is more appropriate in the explaining the relationship because the null hypothesis of random effects was accepted while the alternative hypothesis of fixed effects was rejected. The respective probability values of the Hausman tests for the second and third models were 0.4914 > 0.05 and 0.2216, respectively. Hence, the discussions of models two and three was based on the random effects model.

Testing of hypotheses

The following hypotheses where formulated in order to achieve the objectives of the study.

Test of hypothesis one:

Restatement of the hypothesis in null and alternate forms:

Ho_1: Exchange rate volatility had no significant impact on economic growth in Sub-Saharan African countries.

Ha_1: Exchange rate volatility had a significant impact on economic growth in Sub-Saharan African countries.

Decision rule:

- Reject Ho_1 and accept Ha_1 if probability value is less than 5 per cent (0.05)
- Reject Ha_1 and accept Ho_1 if probability value is greater than 5 per cent (0.05)

Table 4.6: Fixed effect regression results of hypothesis one

Dependent Variable: LNRGDP
Method: Panel Least Squares
Date: 10/30/23 Time: 23:22
Sample: 2000 2022
Periods included: 23
Cross-sections included: 40
Total panel (balanced) observations: 920

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNEXRVOL	-0.106861	0.044372	-2.408276	0.0162

LNTOT	1.508647	0.073006	20.66475	0.0000
LNINT	-0.403686	0.048052	-8.401070	0.0000
C	9.954139	0.393845	25.27427	0.0000

Effects Specification			
Cross-section fixed (dummy variables)			
R-squared	0.903719	Mean dependent var	16.08314
Adjusted R-squared	0.899108	S.D. dependent var	1.481412
S.E. of regression	0.470547	Akaike info criterion	1.375771
Sum squared resid	194.1808	Schwarz criterion	1.601258
Log likelihood	-589.8548	Hannan-Quinn criter.	1.461818
F-statistic	195.9948	Durbin-Watson stat	1.862777
Prob(F-statistic)	0.000000		

Source: Researcher's computations using EViews

The analysis for hypothesis one was also conducted using the annual growth rate of RGDP as presented in Table 4.7:

Table 4.7: Fixed effect regression results of hypothesis one

Dependent Variable: RGDPGR
Method: Panel Least Squares
Date: 04/12/24 Time: 03:30
Sample: 2005 2022
Periods included: 23
Cross-sections included: 40
Total panel (balanced) observations: 920

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNEXRVOL	-1.780128	0.714062	-2.492961	0.0129
LNTOT	-2.394679	0.763019	-3.138425	0.0018
LNINT	1.474613	0.454836	3.242080	0.0012
C	13.37949	4.028241	3.321421	0.0009

Effects Specification			
Cross-section fixed (dummy variables)			
R-squared	0.859838	Mean dependent var	4.031007
Adjusted R-squared	0.808167	S.D. dependent var	5.433057
S.E. of regression	5.130811	Akaike info criterion	6.165618
Sum squared resid	21402.40	Schwarz criterion	6.446683
Log likelihood	-2612.547	Hannan-Quinn criter.	6.273197
F-statistic	11.09343	Durbin-Watson stat	1.949714
Prob(F-statistic)	0.000000		

Source: Researcher's computations using EViews

Outlay of estimated results for hypothesis one

The equations for hypothesis one is derived from the above fixed effects OLS results in Tables 4.6 and 4.7. The estimated regression model is:

$$\text{LNRGDP} = 9.954139 - 0.106861\text{LNEXRVOL} + 1.508647\text{LNTOT} - 0.403686\text{LNINT} + \mu$$

$$\text{RGDPGR} = 13.37949 - 1.780128\text{LNEXRVOL} - 2.394679\text{LNTOT} + 1.474613\text{LNINT} + \mu$$

Tables 4.6 and 4.7, indicates the regression results of the variables analyzed. As shown in the regression table, the constant which is also the intercept of LNRGDP and RGDPGR were 9.95 per cent and 13.38 per cent, respectively. The implication is that the real gross domestic product proxied by LNRGDP would be 9.95 per cent higher if the independent variables are zero. Similarly, RGDP growth rate would increase by 13.38 per cent if the independent are zero.

Assessing the economic *a priori* criteria which refers to sign and size of the parameter of the relationships, LNEXRVOL conformed to the expected sign. The negative signs of -0.106861 and -1.780128 associated with LNEXRVOL indicates that a percentage increase in exchange rate volatility caused approximately 1.07 per cent decrease in RGDP while a percentage increase in exchange rate volatility resulted in a 17.8 per cent decrease in RGDPGR. LNTOT turned out with a positive coefficient of 1.508647, implying that a percentage increase in the terms of trade resulted in about 15.09% increase in RGDP. Also, LNINT has a coefficient of -0.403686 which indicates that a percentage increase in interest rate accounted for about 4.03 per cent decrease in SSA real gross domestic product.

The summary of measure of variation in the predicted variable resulting from variations in the explanatory variable(s) is measured by R-squared and Adjusted R-squared. It is also a measure of goodness of fit. The R-squared which was 0.903719 indicates that about 90 per cent of the variations seen in the dependent variable was explained by the variations in the explanatory variables. The Adjusted R-squared (0.899108) as it test for the goodness of fit of the model holds that approximately 90 per cent of the variation in LNRGDP is attributable to changes in LNEXRVOL, LNTOT and LNINT.

The Durbin-Watson statistic was calculated to be 1.862777, or almost 2. It is well known that the residuals show signs of positive autocorrelation (first order autocorrelation) when DW approaches 0, and that there is no autocorrelation in the residuals when DW is equal to 2. Nevertheless, there

is an issue with negative autocorrelation (2nd order autocorrelation) in the residuals when DW becomes closer to 4. In light of this, it was determined that there was no significant autocorrelation of any order affecting the regression model. This suggested that the model's ability to draw conclusions is trustworthy.

The LNEXRVOL probability value of 0.0162 < 0.05 indicates that this is statistically significant. The probability (F – statistic is 0.00 which is less than 0.05) thus also explained the significance of the model at 5 per cent level. Therefore it is concluded that exchange rate volatility exerted a negative and significant impact on real gross domestic product in SSA.

Decision on hypothesis:

Since the p-values of 0.0162 and 0.0129 are less than 0.05, the alternate hypothesis was accepted. It was therefore concluded that the impact of exchange rate volatility on economic growth was negative and significant in SSA. As such, the alternate hypothesis was accepted and the null hypothesis of no significance was rejected. This decision holds whether economic growth is measured by monetary value of real GDP or by the growth rate of real GDP.

Discussion of Findings

This objective was achieved with the regression results presented in Table 4.6, exchange rate volatility had a statistically significant negative impact on real GDP. This implies that the trend of real gross domestic product of SSA countries would likely have a downward trend when exchange rate volatility increase. In some of the SSA countries, the downward trend of real gross domestic product occasioned by exchange rate volatility could lead to a recession. This also entails that most of the SSA economies are shrinking in terms of productive capacity as a result. Furthermore, the negative real gross domestic product caused be exchange volatility implies that an increase in domestic production will yield no corresponding increases in employment due to exchange rate variability. This negates the theoretical postulation of Solow and Swan that an increase in real gross domestic product increases employment opportunities but this would not be the case in most SSA countries due to the volatility of exchange rate as reflected in the regression result.

The deteriorating effect of exchange rate volatility on real gross domestic product had been acknowledged by some prior empirical works. For instance, among others, the findings of Eklou (2023); Ramoni-Perrazi and Romero (2022) and Olamide et al. (2022) are in line with this study.

The undesirable effect of exchange rate volatility on SSA economies was explained by Sanidas and Hunegnaw (2017) to be as the outcome of exchange rate stabilization policy adopted by the SSA countries as the authorities have not be able to effectively use the policy to manage unnecessary fluctuations of exchange rate in the system because most of the SSA countries are highly indebted to external creditors.

CONCLUSION AND RECOMMENDATION

When accounting for actual gross domestic product, the economic literature demonstrated the connection between the SSA countries' economic growth and exchange rate volatility. This makes it necessary to measure the relationship between real GDP and exchange rate volatility. Whether it is derived from disaggregated or aggregated data, the body of research on the relationship between exchange rate volatility and economic growth is extensive, yet perplexing due to the contradictory empirical results. Using panel least squares and descriptive statistics, the econometric assessment of the relationship between exchange rate volatility and economic growth was conducted in this work. There is a negative correlation between exchange rate volatility and actual gross domestic product, according to panel least squares estimations. The study's empirical findings are open to several interpretations and have important policy ramifications for growth of the SSA economies. According to the study's findings, more exchange volatility discouraged local production as measured by real GDP.

This study found that real gross domestic product was significantly and negatively impacted by exchange rate volatility. Therefore, it was advised that the economy be further diversified by pursuing rapid growth in the non-oil sector in order to boost domestic production and promote the export of primary commodities in which the nation has a comparative advantage. Increased exports indicate export-led growth, which raises the export multiplier and strengthens the nation's comparative advantage in an effort to increase domestic output in the SSA economies.

Conflicts of Interest

The authors have disclosed no conflicts of interest.

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