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An Empirical Assessment of Exchange Rate Depreciation and Currency Substitution in Sierra Leone

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Abstract

This paper investigates the dynamics of exchange rate depreciation and currency substitution in Sierra Leone, focusing on the period between 2020M1 to 2023M5, which is marked by the COVID-19 pandemic, global supply chain disruptions, elevated inflation, the Russia-Ukraine war and interest rate hikes. Currency substitution, defined as the substitution of a domestic currency with a foreign one due to the inefficacy of the former, has been associated with economic instability, adversely impacting living conditions, financial system development, and monetary policy autonomy. The paper employs the ARDL modeling and bounds testing, to analyze variables such as Broad Currency Substitution (BCS), Narrow Currency Substitution (NCS), Nominal Exchange Rate Depreciation (NERD), Gross International Reserves (GIRs), and Consumer Price Index (CPI). The ARDL estimates, which capture both short-run and long-run relationships, highlighted the importance of exchange rate depreciation, gross international reserves, and the consumer price index in influencing currency substitution. The results revealed valuable insights for policymakers in understanding the dynamics of currency substitution in the context of exchange rate depreciation. The study's policy implications emphasize the importance of exchange rate stability, as depreciation emerged as a significant driver of currency substitution. Policymakers are also encouraged to implement measures to build a strong international reserves buffer, control inflation and combat the practice of currency substitution.

Keywords

Exchange Rate Depreciation, Currency Substitution, Gross International Reserves, Consumer Price Index, Sierra Leone

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1. Background

The concept of currency substitution has been extensively discussed in the literature, with varying classifications and no consensus on its definition (see Girton & Roper, 1977; Ho, 2003; Calvo & Vegh, 1992; De Nicolo, Honohan, & Ize, 2005). The idea of currency substitution dates back to the post-World War (I) era when Europe faced severe hyperinflation and a lack of stable domestic means of payment. As a result, foreign currencies were desired not only as a store of value, but also as a means of payment (Gomis-Porqueras, Serrano, & Somuano, 2000). The increasing use of foreign currency often reflects economic agents' attempts to hedge against inflation and exchange rate depreciation during periods of macroeconomic imbalances, particularly high inflation. Few national currencies survive the destructive power of high inflation (Calvo & Vegh, 1992). Like a crippling disease that leaves no part of an organism untouched, high inflation severely hinders the ability of a currency to perform its basic functions as a store of value, a unit of account, and a medium of exchange. Indeed, a currency whose value declines over time, often in an unpredictable manner, is ill-suited to serve as a store of value.

In recent years, currency substitution has been predominantly associated with emerging markets and low-income economies characterized by high inflation and exchange rate fluctuations. These economies often experience episodes of currency substitution due to their economic instability.

By definition, currency substitution can be described as a phenomenon where a domestic currency is being swapped for foreign currency due to the failure of the domestic currency to perform its roles effectively, as a means of payment and store of value. The decision to use domestic or foreign currency by domestic residents depends on the currency's usefulness as a means of payment and as a store of value. The usefulness of a currency is determined mainly by its acceptability; the more people use the currency, the more widely it is accepted, and therefore useful. Hence, a foreign currency is more useful in a country if the currency substitution level is high (Ju, 2020).

Currency substitution has significant implications for the stability of the domestic economy, the development of the financial system, and monetary policy outcomes. It also complicates the independence of exchange rate policy and complicates monetary policy in economies without capital controls or where capital controls are easily circumvented (Mizen & Pentecost, 1994). The preference for foreign currency over domestic currency implies that a significant portion of the money supply is beyond the control of the central bank, making it challenging to achieve price stability. Ho (2003) noted that given a fixed amount of money supply, as domestic currency is substituted for foreign currency, the domestic economy becomes susceptible to monetary shocks both at home and abroad, and hinders any attempts of the monetary authorities to pursue policies independent of foreign influences. In short, currency substitution complicates the implementation of economic policies by limiting the central bank's role as lender of

last resort, weakening the structural fiscal balance and fiscal flexibility by reducing the scope for seigniorage, as well as limiting the government's ability to issue medium-to-long term debt.

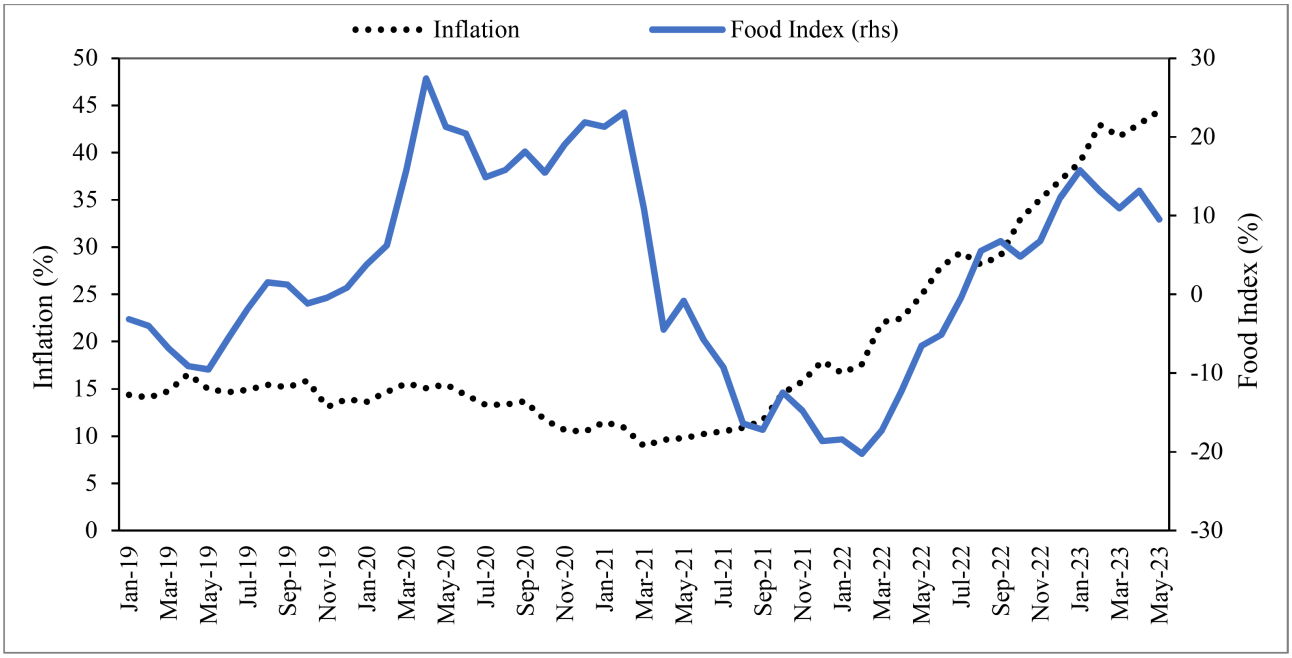
Some scholars have suggested the possibility of positive effects of a reversed currency substitution process. For example, Ramirez-Rojas (1985) argued that improvements in the macroeconomic conditions that triggered the initial currency substitution could lead to a reverse substitution. Domestic residents might repatriate their foreign currency holdings, increasing their demand for domestic currency without significantly impacting inflation.

2. Stylized Facts

The past three to four years have been very challenging for policymakers across the world, especially for low-income and poor countries like Sierra Leone. Macroeconomic variables such as Real GDP growth, exchange rates, and inflation have become volatile and difficult to predict due to multi-layered and complex shocks. Of particular concern during this period is inflation. Inflation was relatively low and stable in 2020 due to low global fuel prices and subdued domestic demand, triggered by COVID-19-related developments. However, the re-opening of the global economy from COVID-19-related lockdowns, coupled with surging global commodity prices and tightening supply chain conditions, led to the re-emergence of global inflationary pressures in the second half of 2021. The outbreak of the war in Ukraine in early 2022 further accelerated the increase in food and energy prices, worsening supply chain conditions and leading to higher imported inflation in the country. Consequently, inflation in Sierra Leone surged, reaching a historical level of 37.1 percent in December 2022 and 44.4 percent in May 2023. The co-movement in global food and domestic inflation became extremely strong after the start of the Russia-Ukraine war in early 2022 as illustrated by the arrow in **Figure 1**.

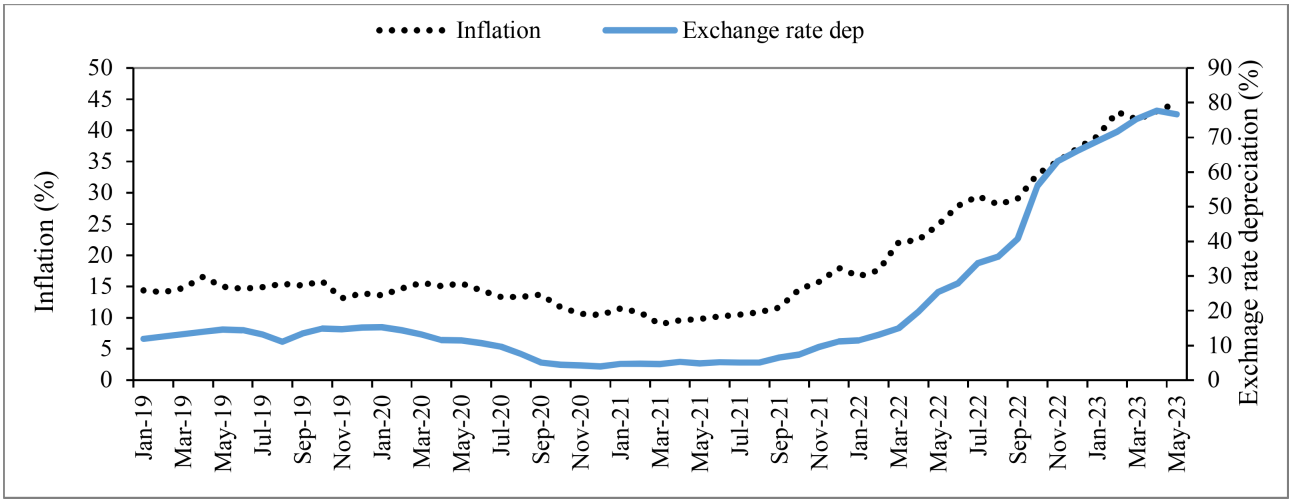
Being an import-dependent country, the surge in the cost of imported commodities increased the demand for foreign currency (US dollars)[1] over its supply in the foreign exchange market. This situation led to a drop in the value of the local currency against the US dollar, starting around the third quarter of 2021. The increase in the US Federal Reserve interest rate in an attempt to curtail inflationary pressures in the US economy further worsened the depreciation of the local currency, with a pass-through effect on domestic inflation. The intertwining dynamics of inflation and exchange rate depreciation eventually became a vicious cycle, feeding into each other. As a result, some economic agents started hoarding US dollars in a bid to preserve the value of their wealth and potentially make a profit by selling the US dollar in the future. **Figure 2** depicts the trend in domestic annual headline inflation and annual exchange rate depreciation of the Leone against the US dollar (Le/USD). The figure shows a strong correlation

[1]This study uses the United States dollar (USD) because it is the most widely used foreign currency in Sierra Leone, and it is the currency used by the Bank of Sierra Leone when conducting its foreign exchange interventions.



Source: World Bank Commodity market outlook and Statistic Sierra Leone.

Figure 1. Global food index and headline inflation.



Source: Bank of Sierra Leone and Statistics Sierra Leone.

Figure 2. Headline inflation and exchange rate depreciation.

between inflationary pressures and exchange rate depreciation, with a correlation coefficient of 98%, which started to become more pronounced around October 2022.

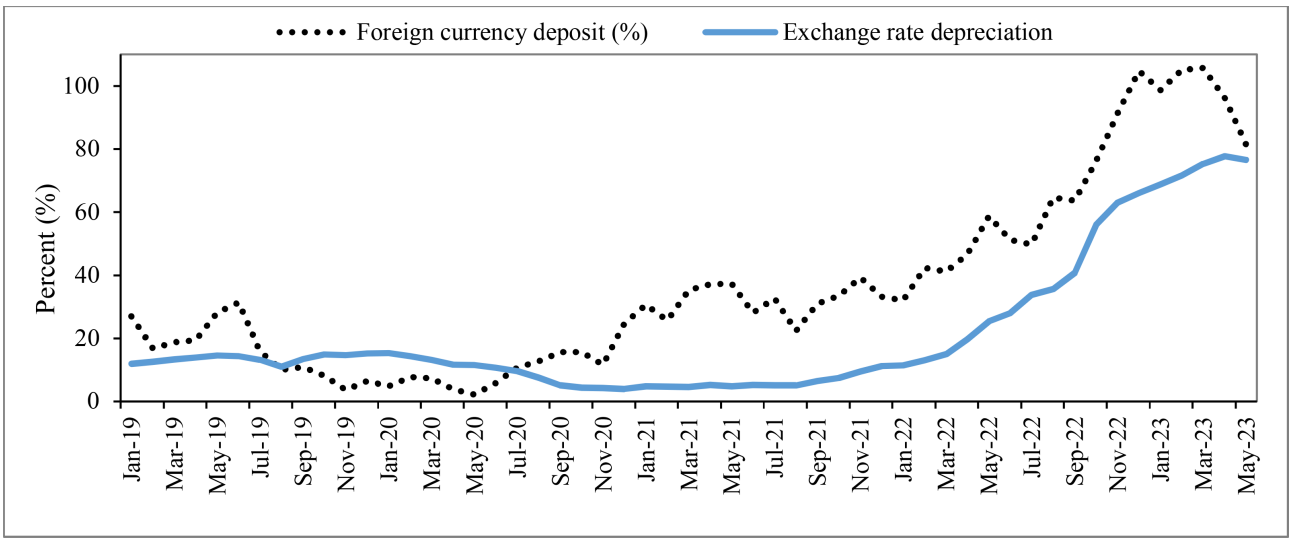
As the depreciation of the domestic currency persists, and the domestic foreign exchange market comes under pressure, the domestic currency starts to lose its role as a store of value. In order words, rational economic agents started substituting the domestic currency for foreign currency (the US dollar) as a way of preserving their purchasing power. This is consistent with the findings of Tanzi and Blejer (1982), who contended that economic agents are forced to respond to

high inflation by reducing their holdings of domestic currency and substituting with foreign currencies, and that as a consequence, this substitution often leads to depreciation of the exchange rate. In the context of Sierra Leone, this phenomenon manifested through a substantial increase in the share of foreign currency deposits held by customers in the commercial banks. This shift commenced around the third quarter of 2021 with 22 percent increase in foreign currency deposit. The trend worsened in the fourth quarter of 2022 when the increase in foreign currency deposit peaked by 105 percent, before tapering-off in the first half of 2023 as shown in **Figure 3**.

These assessments suggest a story of currency substitution emerging due to high inflationary pressures in Sierra Leone in 2022, eroding the Leone's purchasing power. The depreciation of the domestic currency eventually led to its substitution with the US dollar during the same period.

As previously mentioned, many studies have underscored the potential ramifications on the effectiveness of macroeconomic policy, and in particular, the ability of the monetary authority to formulate and conduct monetary policy in the face of currency substitution which is typically occasioned by depreciation of the domestic currency. As noted by Bahmani-Oskooee and Techaratanachai (2001), depreciation of the domestic currency raises the currency value of foreign assets. Consequently, individuals anticipating further depreciation tend to substitute more foreign currency for domestic currency, thereby reducing their domestic money holdings. If these effects are strong, the decline in domestic currency holdings could cause economic slowdown and further aggravate economic crisis.

Given the significance of currency substitution in the context of exchange rate depreciation and its potential impact on economic policy, this study seeks to empirically investigate the practice of currency substitution in Sierra Leone, focusing on the post-COVID period. This period is characterized by global supply



Source: Bank of Sierra Leone.

Figure 3. Foreign currency deposits and exchange rate depreciation.

chain disruptions, high food and energy prices that resulted in elevated inflation across the globe, high interest rates in the United States that increased the strength of the US dollar and the Russia-Ukraine war. This research aims to provide evidence-based insights for policy making in Sierra Leone and similar economies. Understanding the extent of currency substitution and its potential impact is crucial for policy makers in the current economic situation in Sierra Leone.

The remainder of the paper is structured as follows: Section 3 reviews the literature, highlighting theoretical and empirical works. Section 4 presents the econometric techniques employed, while Section 5 discusses the results. Finally, Section 6 provides concluding remarks and policy implications on the paper.

3. Literature Review

The relationship between exchange rates and currency substitution has garnered significant attention in the literature, particularly in the context of developing and low-income countries facing economic instability. This review aims to provide an overview of the theoretical and empirical literature on the exchange rate and currency substitution nexus to shed light on the dynamics at play and offer insights for understanding this phenomenon in Sierra Leone.

3.1. Theoretical Literature

The concept of currency substitution is often interpreted in two distinct ways. It can refer to the concurrent use of foreign currency alongside domestic currency in economic and financial transactions or the adjustment of the quantity of foreign currency balances in response to shifts in domestic economic variables (Yildirim, 2001). Currency substitution is attributed to the substitution between two currencies, primarily driven by shifts in domestic and foreign economic variables or institutional changes.

Recent theoretical models emphasize the link between exchange rate volatility and currency substitution. In a context of high inflation and exchange rate fluctuations, individuals may seek to protect their wealth by substituting domestic currency for foreign currency (Yinusa & Akinlo, 2008a). This notion is relevant for Sierra Leone, especially in light of its recent exchange rate depreciation.

The economic significance of currency substitution arises from the existence of economic agents who, given the prevailing economic conditions, hold both domestic and foreign currency balances and are indifferent at the margin between holding more domestic or foreign balances (Miles, 1978). In that sense, currency substitution is attributed to the substitution between two currencies, which can be induced by shifts in domestic and/or foreign economic variables, or institutional changes. This interpretation aligns with the use of the term by Cuddington (1983) and Miles (1978).

Many studies suggest that countries with high inflation and volatile exchange

rates tend to have a high opportunity cost of holding their domestic currency. This prompts economic agents to have confidence in foreign currencies as a store of value and a medium of transaction (see Reinhart, Rogoff, & Savastano, 2003). This perspective highlights the inverse relationship between the demand for the domestic currency and inflation, as individuals seek to hedge against the loss of purchasing power associated with high inflation and exchange rate fluctuations.

3.2. Empirical Literature

From the empirical perspective, numerous studies have explored the prevalence of currency substitution and exchange rate volatility, with particular emphasis on developing and low-income economies.

In a related study, Tarawalie and Jalloh (2020) used consumer price index, foreign direct investment, gross domestic product, exchange rate, financial deepening and a proxy for deposit dollarization to examine the determinants of dollarization in Sierra Leone between the period 1992 to 2017. Their findings revealed that inflation, exchange rate depreciation, and financial deepening emerged as the primary determinants of dollarization in Sierra Leone during the study period. More precisely, their regression analysis indicated that, in the long run, a one percentage point depreciation of the Leone against the US dollar would result in a 0.07 percent increase in dollarization. However, despite their study's scope predating the recent significant depreciation of the Leone that began in early 2022, their findings still underscore the seemingly ongoing challenge of Leone depreciation, which continues to drive domestic economic agents to substitute it for the US dollar.

Mengesha and Holmes (2013) used quarterly Eritrean data spanning from 1996 to 2008, to investigate whether currency substitution alleviates exchange rate fluctuations. The results showed a bi-directional causal relationship between currency substitution and exchange rate fluctuations, although the causality running from currency substitution to exchange rate fluctuations seems stronger.

Kaplan, Kalyoncu, and Yucel (2008) researched whether exchange rate depreciation in Türkiye led to currency substitution away from the Turkish Lira to the U.S. dollar. Their study involved estimating a money demand function as a function of real income, nominal domestic interest rate and the nominal effective exchange rate. Employing the Johansen and Juselius cointegration technique, their analysis revealed the existence of a single cointegrating relationship. The long-run model showed that all variables were significant, with the positive sign on the nominal exchange rate variable confirming the existence of currency substitution.

Adom, Sharma, and Morshed (2007) used both local currencies and the US dollar as anchor currencies to examine the evidence of currency substitution in eight African countries over the period from 1976 to 2005. These countries include Egypt, Morocco, Nigeria, Ghana, Kenya, South Africa, Tunisia, and Zam-

bia. Their analysis found that when the CFA franc is utilised as an anchor currency, currency substitution was prevalent in Ghana and Nigeria. However, when the US dollar served as the anchor currency, Ghana showed no signs of currency substitution, but Nigeria continued to show these signs. Moreover, when the US dollar is the anchor currency, currency substitution was observed in South Africa but not Egypt. On the other hand, regardless of the anchor currencies considered, there was no evidence of currency substitution for Kenya, Tunisia, or Zambia. In a specific scenario using the Egyptian pound as the anchor currency, they found no evidence of currency substitution in the case of Morocco, though some evidence emerged when the US dollar was used as the anchor currency. In another study, Wang (2017) studied the Demand for Money in China with Currency Substitution. The study finds that currency substitution has a significant negative effect on the demand for M2 and M1 in China, indicating that the public may increase the value of assets by increasing the holdings of foreign currencies to avoid further domestic currency depreciation.

In a more comparative analysis, Elkhafif (2003) examined the exchange rate policy and currency substitution in two of Africa's emerging economies: South Africa and Egypt. The paper adopts an Error Correction Model (ECM) based on data spanning from 1991 to 2001. The findings revealed some currency substitution-related differences between the two countries. First, the study highlighted variations in the orientation of economic policy and the instruments used. While Egypt used exchange rate as an anchor to its economic stabilization program, South Africa adopted an inflation targeting framework. Second, the degree and level of currency substitution also differed. Currency substitution commenced at a very high level in Egypt, but steadily declined by the end of the study period. Conversely, South Africa initially exhibited a low level of currency substitution, but increased significantly by the end of the period. However, a common finding observed in both countries was the impact of exchange rate fluctuations on currency substitution. The author concludes that irrespective of the policy orientation (exchange rate targeting or inflation targeting), the depreciation of the domestic currency leading to currency substitution, particularly when caused by chronic current account deficits, could undermine the success of these policies. The paper proposed that enhancing productivity and competitiveness within the economy is the key reduce the depreciation pressures and curb the practice of currency substitution.

On the other hand, few studies offer contrasting evidence regarding the relationship between currency substitution and exchange rate fluctuations. For instance, Akinlo (2003) in a study spanning 1980 to 2000, assessed whether the exchange rate depreciation of the Naira has a significant effect on currency substitution in Nigeria. His findings indicated that Naira depreciation during the study period did not lead to currency substitution. Instead, as Naira depreciates, those holding foreign currencies perceived it as an increase in their wealth. However, this conclusion does not imply that depreciation of the naira did not trigger

currency substitution. If the depreciation of the naira persists over time, then rational economic agents may start to demand foreign currency as a means of preserving their wealth. In fact, other latter studies (Ajibola, Udoette, Muhammad, & Anigwe, 2020; Yinusa & Akinlo, 2008a, 2008b) provided support for the notion that depreciation of the naira has indeed been a significant driver of currency substitution in Nigeria. For instance, Yinusa and Akinlo (2008b) employed a multi-perspective unrestricted portfolio balance approach using data from the period of liberalization, spanning from 1968 to 2005, and their findings emphasized the crucial role of naira depreciation in the parallel market as a driving force behind currency substitution.

4. Methodology

As established in the literature review, currency substitution in an economy is primarily influenced by exchange rate depreciation and rapid price increases. Additionally, gross international reserves play a significant role, as higher reserves empower the Central Bank to intervene in the foreign exchange market to mitigate depreciation pressures. Therefore, this study employs five variables: Broad Currency Substitution (BCS), Narrow Currency Substitution (NCS), Nominal Exchange Rate Depreciation (NERD), Gross International Reserves (GIRs), and Consumer Price Index (CPI).

Based on preliminary unit root and cointegration test results, the empirical investigation of currency substitution in Sierra Leone is conducted using the Autoregressive Distributed Lag (ARDL) model and bounds testing. The ARDL model allows for the examination of both short-run and long-run relationships between variables. Specifically, this methodology will enable the assessment of the impact of nominal exchange rate depreciation, international reserves, and consumer price index on both Broad and Narrow Currency Substitution in Sierra Leone. Also, since the regressors are a mixture of I(0) and I(1) variables, the ARDL is a perfect model to estimate relationship among them. Therefore, in this study, two separate ARDL models are estimated, each focusing on a slightly different definition of currency substitution.

BCS is the ratio of foreign currency denominated deposit to the sum of demand deposit, term deposit and savings deposits. It captures currency substitution in terms of the foreign currency displacing the national currency as a store of value mainly due to high inflation. It is mathematically computed as follows:

$$\mathrm{BCS} = \frac{\mathrm{FCD}}{\mathrm{DD} + \mathrm{TSD}} \tag{1}$$

where BCS refers to the Broad Currency Substitution, FCD is the Foreign Currency Deposit, DD is Demand Deposit and TSD is Time and Saving Deposit.

The second measure of Currency substitution is Narrow Currency Substitution (NCS), which represents the ratio of foreign currency deposit to the Leone demand deposit in the commercial banks. This captures currency substitution in terms of the foreign currency displacing the national currency as a medium of

exchange. The NCS is derived as follows:

$$\text{NCS} = \frac{\text{FCD}}{\text{DD}} \tag{2}$$

where NCS refers to Narrow Currency Substitution, FCD is Foreign Currency Deposit and DD is Demand Deposit.

4.1. Model Specification

The general form of the ARDL model can be expressed as follows:

$$\begin{aligned}\Delta Y_t = {} & \alpha_0 + \beta_1 \Delta Y_{t-1} + \beta_2 \Delta X_{1,t} + \beta_3 \Delta X_{2,t} + \beta_4 \Delta X_{3,t} \\ & + \gamma_1 Y_{t-1} + \gamma_2 X_{1,t} + \gamma_3 X_{2,t} + \gamma_4 X_{3,t} + \varepsilon_t\end{aligned} \tag{3}$$

where:

Y_t is the dependent variable (BCS or NCS).

$X_{1,t}$, $X_{2,t}$, and $X_{3,t}$ are the independent variables (NERD, LGIRs, LCPI).

Δ denotes the first difference.

α is a constant term.

β_1, β_2, β_3, and β_4 are coefficients for the lagged and contemporaneous changes in the independent variables.

γ_1, γ_2, γ_3, and γ_4 are coefficients for the lagged and contemporaneous levels of the independent variables.

ε_t is the error term, capturing other factors influencing currency substitution in Sierra Leone.

4.2. Model Estimation

Estimation is carried out using appropriate econometric techniques, with a focus on the following steps:

- **Data Preparation:** Data is prepared for analysis by ensuring it is stationary, and where necessary, first differences have been taken to achieve stationarity.
- **Lag Selection:** The appropriate lag length for the model is chosen using criteria such as the Akaike Information Criterion (AIC) and the Schwarz Criterion (SC).
- **Model Estimation:** The ARDL model was employed to estimate the coefficients for both the short-run and long-run relationships.
- **Cointegration Analysis:** The check for cointegration is done using the bounds testing approach due to its strength of accuracy (see Pesaran et al., 2001; Pesaran & Shin, 1995).
- **Interpretation of Results:** The estimated coefficients are interpreted with a focus on both short-term dynamics and long-term equilibrium relationships.

4.3. Model Specification for BCS

$$\begin{aligned}\Delta \text{BCS}_t = {} & \alpha_0 + \beta_1 \Delta \text{BCS}_{t-1} + \beta_2 \Delta \text{NERD}_t + \beta_3 \Delta \text{LGIRs}_t + \beta_4 \Delta \text{LCPI}_t \\ & + \gamma_1 \text{BCS}_{t-1} + \gamma_2 \text{NERD}_t + \gamma_3 \text{LGIRs}_t + \gamma_4 \text{LCPI}_t + \varepsilon_t\end{aligned} \tag{4}$$

4.4. Model Specification for NCS

$$\begin{aligned}\Delta \mathrm{NCS}_t = {} & \alpha_0 + \beta_1 \Delta \mathrm{NCS}_{t-1} + \beta_2 \Delta \mathrm{NERD}_t + \beta_3 \Delta \mathrm{LGIRs}_t + \beta_4 \Delta \mathrm{LCPI}_t \\ & + \gamma_1 \mathrm{NCS}_{t-1} + \gamma_2 \mathrm{NERD}_t + \gamma_3 \mathrm{LGIRs}_t + \gamma_4 \mathrm{LCPI}_t + \varepsilon_t\end{aligned} \tag{5}$$

The coefficients β_1, β_2, β_3, and β_4 will capture the short-term dynamics, while γ_1, γ_2, γ_3, and γ_4 will capture the long-term equilibrium relationships.

4.5. Data Sources

Monthly time series data on the variables in the study have been sourced from the Bank of Sierra Leone and Statistics Sierra Leone databases. Data is collected for the period covering January 2020 to May 2023 (41 observations).

4.6. Robustness Checks

Robustness checks are conducted by considering alternative specifications, such as different lag lengths, to ensure the stability and reliability of the estimated models. Diagnostic tests, including the Breusch-Godfrey test for serial correlation, the White test for heteroskedasticity, and the Ramsey RESET test for functional form misspecification were done. The stability test of the regression parameters is undertaken using Brown et al.'s (1975) stability testing technique, also known as cumulative sum of recursive residuals (CUSUM) and the cumulative sum of squares of recursive residuals (CUSUMQ).

5. Presentation and Discussion of Empirical Results

5.1. Descriptive Statistics

A summary of the descriptive statistics for all the time series variables used in the study is presented in Table 1. This summary provides an overview of the measures of central tendency, dispersion, normality, and stability for these variables. The Mean values, representing the average values of the variables, range between −0.98 and 6.51. Notably, LBCS exhibits the lowest mean value, while LGIRS has the highest mean value. The Maximum and Minimum values indicate the highest and lowest extreme values of each time series. NERD has the highest maximum value of 13.06, whereas LBCS registers the lowest minimum value of −1.27.

As a measure of dispersion, the standard deviation of all the observations is presented. The relatively low standard deviation values across all the variables indicate that they display a stable and consistent behavior over time, with the exception of the NERD time series. Regarding asymmetry, the skewness measure reveals that all the variables are positively skewed. Kurtosis values, representing flatness or peakness of the series, suggest that all variables show signs of flatness, with values falling below the threshold of 3. However, the NERD variable deviates from this trend, indicating peakness with a Kurtosis value of 8.57, surpassing the threshold. Moreover, the Jacque-Bera statistic and its accompanying probability tests suggest that the series are normally distributed, with an exception

Table 1. Presentation of descriptive statistics.

	LBCS	LNCS	NERD	LGIRS	LCPI
Mean	−0.97561	−0.57737	2.12174	6.50992	4.63400
Median	−1.05967	−0.68026	1.13936	6.51798	4.57448
Maximum	−0.55252	−0.16932	13.06021	6.85951	5.10879
Minimum	−1.27301	−0.86669	−0.50650	6.21537	4.35578
Std. Dev.	0.21460	0.20506	2.61732	0.19385	0.21344
Skewness	0.76673	0.82260	2.05804	0.25878	0.71889
Kurtosis	2.19366	2.31155	8.57316	2.17623	2.32542
Jarque-Bera	5.12783	5.43365	82.00375	1.61686	4.30884
Probability	0.07700	0.06608	0.00000	0.44556	0.11597
Sum	−40.00004	−23.67217	86.99146	266.90680	189.99390
Sum Sq. Dev.	1.84215	1.68206	274.01500	1.50315	1.82222
Observations	41	41	41	41	41

Source: Author's estimate using E-views 13.

in the case of the NERD variable.

In summary, the descriptive statistics of the time series variables used in this study indicate that they generally exhibit relatively good statistical properties, except for the NERD variable. This divergence is attributed to the fact that, unlike the other variables, NERD did not undergo logarithmic transformation. This is simply because the NERD was found to be stationary at level and was therefore used in the model in level form, avoiding the inevitable loss of important long-run information of the variable.

5.2. Unit Root Tests

This paper adopts a robust and multiple unit root tests to ascertain the true stationarity characteristics of the variables. The practice of employing multiple unit root tests is substantiated by its capacity to enhance model robustness. Each unit root test has its own assumptions and limitations, and the power to detect unit roots may vary based on specific conditions. Therefore, employing a diverse range of unit root tests can reduce the risk of making erroneous conclusions due to the specific characteristics of one test.

In this regard, the paper utilizes the Augmented Dickey-Fuller (ADF) test, Phillips-Perron (PP) unit root test, as well as Break Point unit root tests designed to account for innovative and additive outliers. Unit root tests can be sensitive to specific data characteristics, such as structural breaks or outliers. Therefore, in addition to relying on the ADF and PP tests for unit roots, Break Point unit root tests are employed to address potential structural breaks in the time series induced by the COVID-19 shock that started in 2020 and the Russia-Ukraine war.

The results of these various unit root tests indicate that, with the exception of NERD, all the variables are stationary at first difference (i.e. integrated of order one, I(1)), as suggested by the ADF, PP, and Innovative Break Point tests. Concurrently, all the unit root tests affirm that NERD is stationary at level (i.e. I(0)).

A variable is considered stationary when at least one of the methods reveals stationarity. Therefore, LGIRS and LCPI are declared I(1), while LBCS, LNCS and NERD are used as I(0) variables.

It's worth noting that the number of lags used in the unit root tests was 12, guided by the frequency of the data (monthly). The result of the unit root tests is shown in Table 2.

5.3. ARDL Estimates

Given the mixed order of integration of the variables used in this study, the use of the ARDL model was necessitated for both models. In addition, the ARDL model is relatively more efficient in the event of relatively small sample size, as is the case in this paper which uses 41 time series observations.

The model selection method for the ARDL model is Akaike Information Criteria (AIC). The choice of the AIC is due to its ability to balance model fit and parsimony. In particular, the AIC tend to penalize the addition of extra parameters to the model, preventing overfitting. This is particularly useful when dealing with relatively small sample sizes, as is the case in this study.

For each model, the selected optimal lag form of the ARDL model is (1, 1, 0, 1). Furthermore, the Heteroskedasticity and Autocorrelation Consistent (HAC) standard errors and covariance matrix estimation method was applied to both models. This method ensures more efficient and reliable hypothesis testing, as its better accounts for the probable correlation between error terms.

As stated in Section 3, Model 1 consists of LBCS as the endogenous variable, while the exogenous variables include NERD, LGIRS and LCPI. The ARDL output for Model 1 is presented in Table 3, showing the short-run ARDL results. All the variables bear statistically significant coefficients. More precisely, the result shows that all else being equal, a 1 unit increase in the exchange rate depreciation

Table 2. Summary of unit root test results.

Variables	Traditional Unit Root Tests		Break Point Unit Root Tests		Decision
	ADF	PP	Innovative Outlier	Additive Outlier	I(d)
LBCS	I(1)	I(1)	I(1)	I(0)	I(0)
LNCS	I(1)	I(1)	I(1)	I(0)	I(0)
NERD	I(0)	I(0)	I(0)	I(0)	I(0)
LGIRS	I(1)	I(1)	I(1)	I(1)	I(1)
LCPI	I(1)	I(1)	I(1)	I(1)	I(1)

Source: Author's estimate using E-views 13.

Table 3. Short-run ARDL(1, 1, 0, 1) estimates for Model 1.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LBCS(−1)	0.4052	0.1191	3.4025	0.0018
NERD	0.0108	0.0029	3.7080	0.0008
NERD(−1)	0.0076	0.0033	2.2843	0.0289
LGIRS	−0.0934	0.0375	−2.4908	0.0180
LCPI	2.0411	0.4701	4.3421	0.0001
LCPI(−1)	−1.7056	0.4715	−3.6174	0.0010
C	−1.5952	0.5175	−3.0823	0.0041

Source: Author's estimate using E-views 13.

is, on average, associated with a 0.01 percentage increase in the level of currency substitution in the short run. This relationship demonstrates statistical significance at the 1 percent level. This result implies that depreciation of the Leone against the US dollar led to an increase in the level of currency substitution during the study period.

Similarly, the result revealed that a 1 percentage build up in the gross international reserves is, on average, associated with a 0.09 percentage reduction in the level of currency substitution. This result is in-line with the effort made by central banks to increase their stock of reserves, enabling intervention in the foreign exchange market to stabilize exchange rate fluctuations. In addition, the coefficient of the LCPI suggests that, on average, a 1 percentage increase in the consumer price index corresponds to a 2.0 percentage increase in the level of currency substitution in the short run.

From the value of the R-squared, it shows that approximately 97% of variations in the dependent variable, namely LBCS, can be explained by changes in the independent variables. Furthermore, the overall probability value, significant at the 1% level, substantiates the joint significance of the independent variables in explaining the dependent variable.

The ARDL output for Model 2 closely mirrors the findings observed in Model 1. Notably, the variables carry the expected signs and are statistically significant. The coefficient on the NERD shows that, in the short run, a 1-unit depreciation of the exchange rate is, on average, is associated with approximately 0.01 percentage increase in (broad) currency substitution, holding all other factors constant. Also, a 1 percentage increase in the gross international reserves corresponds to an average 0.14 percentage increase in the level of (broad) currency substitution. Additionally, the result shows that, in the short run, a 1 percent increase in prices is, on average, associated with approximately 1.87 percent increase in the level of (broad) currency substitution.

Similar to Model 1, the R-squared value for Model 2 shows that approximately 97% of variations in the dependent variable, i.e. LNCS can be accounted for by changes in the independent variables. Furthermore, based on the probability value,

the independent variables in the model are highly statistically significant at 1% in explaining the LNCS as shown in Table 4.

5.4. Bounds Test results

According to the bounds test results in Table 5, the calculated F-statistics for both Model 1 (6.577) and Model 2 (7.628) surpass the upper bound I(1) critical values. This outcome indicates the rejection of the null hypothesis of no cointegration. In order words, it essentially implies that there is a cointegrating relationship between the variables in both models.

5.5. Error Correction Model

The results of the error correction estimate for the models are computed a presented in Table 6 and Table 7. The error correction terms, which indicate the speeds of adjustment for Models 1 and 2, are −0.595 and −0.537 respectively. Both are statistically significant at the 1% level. This implies if there is a disequilibrium in Models 1 and 2, the speed of adjustment from the short run to the long run is approximately 59.5 percent and 53.7 percent, respectively.

Moreover, the results in both Table 6 and Table 7 demonstrate that in the

Table 4. Short-run ARDL(1, 1, 0, 1) estimates for Model 2.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNCS(−1)	0.4778	0.0917	5.2096	0.0000
NERD	0.0096	0.0022	4.4079	0.0001
NERD(−1)	0.0057	0.0024	2.3325	0.0259
LGIRS	−0.1399	0.0332	−4.2183	0.0002
LCPI	1.8653	0.4750	3.9268	0.0004
LCPI(−1)	−1.5990	0.4635	−3.4496	0.0016
C	−0.6843	0.2816	−2.4298	0.0207

Source: Author's estimate using E-views 13.

Table 5. Bounds test for Models 1 and 2.

	Model 1		Model 2	
F-statistic	6.577		7.628	
	5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)
35	3.164	4.194	4.428	5.816
40	3.1	4.088	4.31	5.544
Asymptotic	2.79	3.67	3.65	4.66

Null hypothesis: No levels relationship; *I(0) and I(1) are respectively the stationary and non-stationary bounds.

Table 6. Error correction model for Model 1.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECT	−0.59479	0.09796	−6.07194	0.0000
D(NERD)	0.01078	0.00286	3.76399	0.0006
D(LCPI)	2.04106	0.34070	5.99082	0.0000

Source: Author's estimate using E-views 13.

Table 7. Error correction model for Model 2.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ECT	−0.53652	0.08064	−6.65342	0.0000
D(NERD)	0.00996	0.00275	3.62161	0.0010
D(LCPI)	1.72583	0.30909	5.58351	0.0000

Source: Author's estimate using E-views 13.

short run, the depreciation of the Leone against the US dollar is positively associated with the practice of currency substitution. This relationship is found to be significant at the 1 percent level.

Additionally, the result reveal that inflation is positively related to currency substitution in the short run, and is statistically significant at the 1% level. This also aligns with the economic literature on currency substitution, which posits that as inflation rises and the domestic currency depreciates in value, economic actors are inclined to substitute domestic currency for foreign currency. This action contributes to the escalation of currency substitution within the economy.

5.6. Long-Run Model Estimates for Models 1 and 2

Having established cointegration for both models, the long-run estimates are subsequently computed. The outcomes of the long-run model show that there is a significant and long-run relationship between the variables and the two measures of currency substitution in both models. For example, in Model 1, a statistically significant long-run relationship exists between the one-month lag of exchange rate depreciation and currency substitution for both models. In essence, these results suggest that the depreciation of the Leone against the US dollar exacerbates the practice of currency substitution in the long run. Likewise, an increase in the one-month lag of the CPI corresponds to a heightened incidence of currency substitution in the long run. Conversely, an increase in the country's stock of international reserves reduces the level of currency substitution in the long run. The regression results depicting the long-run relationships for both models are presented in Table 8 and Table 9.

5.7. Diagnostics Tests

To confirm the robustness of the results, post estimation diagnostics tests, in-

cluding heteroscedasticity, serial correlation, normality and stability tests are conducted on both models. The outcomes of these diagnostic tests are presented in Table 10 as well as Figure 1 and Figure 2.

The Breusch-Pagan-Godfrey test for Heteroscedasticity, renowned for its capacity to detect a wide range of heteroscedastic patterns in regression analysis, indicates that both models passed the Heteroscedasticity test. In addition, the test for normality using the Jacque-Bera test indicates that the errors follow a normal distributed in both models. However, the Breusch-Godfrey LM Test for Serial Correlation suggests that while Model 1 passed the serial correlation test, it detects the presence of serially correlated errors in Model 2. This outcome is likely attributed to the small sample size used in the study. Serial correlation tests typically rely on sufficient data points, and with only 40 data points, the test's ability to detect serial correlation is diminished. Consequently, distinguishing true serial correlation from random noise is made difficult.

Finally, the diagnostic tests assess the stability of the models using the Cumulative Sum Recursive Residual (Cusum) and the Cumulative Sum of Squares

Table 8. Long-run estimates for Model 1.

Variable*	Coefficient	Std. Error	t-Statistic	Prob.
NERD(−1)	0.0309	0.0082	3.7813	0.0006
LGIRS	−0.1570	0.0581	−2.7030	0.0104
LCPI(−1)	0.5641	0.0998	5.6520	0.0000
C	−2.6820	0.5486	−4.8886	0.0000

Source: Author's estimate using E-views 13.

Table 9. Long-run estimates for Model 2.

Variable*	Coefficient	Std. Error	t-Statistic	Prob.
NERD(−1)	0.0292	0.0089	3.2943	0.0022
LGIRS	−0.2680	0.0622	−4.3071	0.0001
LCPI(−1)	0.5101	0.1067	4.7801	0.0000
C	−1.3104	0.5990	−2.1876	0.0353

Source: Author's estimate using E-views 13.

Table 10. Diagnostic test results.

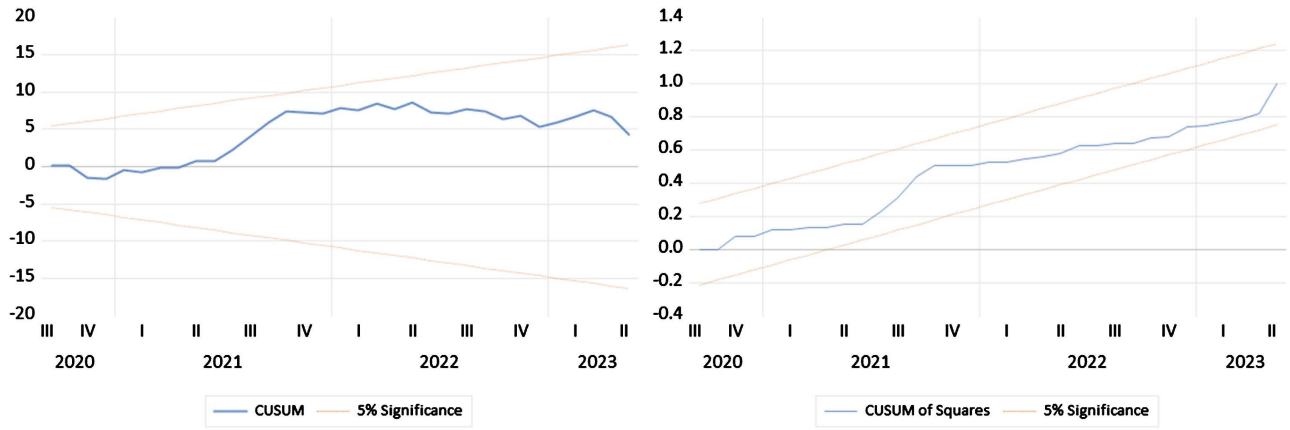
Test	Test Type	Model 1		Model 2	
		F-statistic	Prob.	F-statistic	Prob.
Heteroskedasticity	Breusch-Pagan-Godfrey	1.2220	0.3201	0.4476	0.8414
Serial Correlation	Breusch-Godfrey LM Test	2.5199	0.0968	4.1591	0.0251
Normality	Jarque-Bera		0.3580		0.6380

Source: Author's estimate using E-views 13.

Recursive Residual (Cusum of Squares). As illustrated in Figure 4 and Figure 5, both models are declared stable, since the test statistics for both the Cusum and Cusum of Squares remain within the 5% critical bounds in both models.

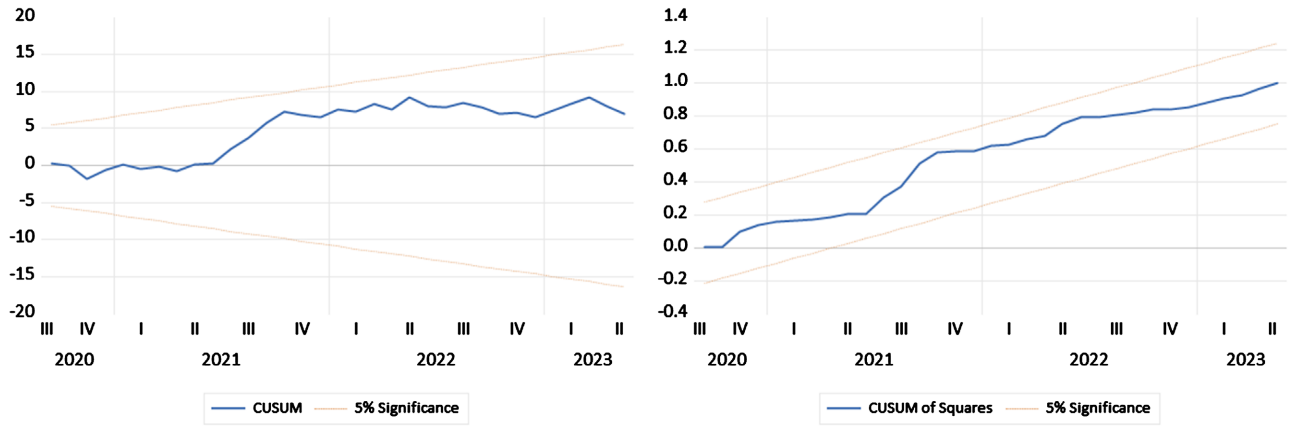
6. Conclusion

This study has investigated the relationship between exchange rate depreciation and currency substitution in Sierra Leone. The investigation, spanning the post-COVID-19 era and the Russia-Ukraine conflict, employed robust methodologies to enhance the empirical analysis. Rigorous unit root tests were conducted using diverse unit root tests, such as the Augmented Dickey-Fuller (ADF) test, Phillips-Perron (PP) unit root test, and Break Point unit root tests. The combination of these tests suggested mixed I(0) and I(1) order of integrations among the variables. Given the mixed order of integration, the Autoregressive Distributed Lag (ARDL) model was employed to capture both short-run and long-run relationships. Two concepts of currency substitutions were investigated using two ARDL models, namely an ARDL model for Broad Currency substitution and a



Source: Author's estimate using E-views 13.

Figure 4. Stability test for Model 1.



Source: Author's estimate using E-views 13.

Figure 5. Stability test for Model 2.

second ARDL model for Narrow Currency substitution. The bounds test results provided evidence of cointegration between variables in both models, reinforcing the presence of a long-term relationship.

The study reveals significant findings regarding currency substitution in Sierra Leone. The exchange rate depreciation, triggered by global events such as the Russia-Ukraine war, led to an increase in currency substitution, particularly the preference for the US dollar. The surge in inflation and depreciation created a vicious cycle, with economic agents hoarding US dollars to preserve wealth. Error correction estimates highlighted the short-run dynamics of this relationship between currency substitution, exchange rate depreciation, and inflation. The speed of adjustment from short run to long run was found to be significant, indicating the resilience of currency substitution to short-term shocks. The long-run model estimates further solidified the relationships established in the short run. Notably, exchange rate depreciation was identified as a significant factor exacerbating currency substitution, while an increase in international reserves was associated with a reduction in currency substitution in the long run.

The findings of this study have crucial policy implications for Sierra Leone. It underscores the importance of a stable exchange rate, as depreciation was identified as a key driver of currency substitution. This research significantly contributes to the understanding of exchange rate depreciation and currency substitution dynamics in Sierra Leone, especially in the context of global economic shocks. The innovation lies in the comprehensive analysis of the post-COVID-19 and Russia-Ukraine conflict periods, shedding light on the interplay between exchange rate depreciation, inflation, and the propensity for currency substitution using a two-model approach.

Policymakers may consider measures to stabilize the exchange rate to reduce the incentive for individuals to substitute the domestic currency with foreign currencies. Increasing gross international reserves also emerged as a potential strategy to counteract currency substitution. Policymakers are urged to intensify measures and efforts aimed at bolstering reserves, providing the central bank with more tools to intervene in the foreign exchange market and maintain stability. More importantly, given the positive relationship between inflation and currency substitution, controlling inflation becomes paramount. Policy measures aimed at curbing inflationary pressures can contribute to maintaining confidence in the domestic currency.

However, it is important to acknowledge the study's limitation, including the relatively small sample size that hinted at the presence of serially correlated errors in one of the models. Future research could address this limitation by incorporating a larger dataset and conducting a more in-depth analysis of the impact of some of the fundamental drivers of exchange rate depreciation and currency substitution during the study period. Notably, an exploration into the impact of events such as the Russia-Ukraine war on the intricate dynamics between exchange rate depreciation and currency substitution would contribute significantly

to our understanding of these phenomena.

In conclusion, this study advances our understanding of the dynamics between exchange rate depreciation and currency substitution in Sierra Leone and provides actionable insights for policymakers to navigate economic challenges effectively. The complexities of global events and their impact on domestic economies underscore the importance of continuous research and adaptive policy frameworks to foster economic stability and resilience.

Declaration

The views expressed in this paper are those of the authors and do not necessarily represent the views of neither the Bank of Sierra Leone nor the West African Monetary Institute.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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