The Effects of Exchange Rate Depreciation and World Energy and Food Prices on Inflation in Sierra Leone: An Instrumental Variable Estimation Technique

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Abstract

The paper investigates the effects of exchange rate, world energy price and world food price on inflation rate in Sierra Leone using monthly data from January 2020 to December 2024. The methodology involves using the Instrumental Variables (IV) estimation to account for two-way feedback effect between inflation and exchange rate while accounting for the effect of non-stationarity of variables on model estimates. The estimated model reveals that exchange rate depreciation has a significant positive effect on inflation in Sierra Leone, as in the case of world energy price. However, world food price is not found to be of significant impact, while it has a strong correlation with world energy prices. However, the impact of exchange rate is found to almost double the effect of world energy price as they have contemporaneous beta coefficients of 0.34 and 0.18, respectively. The result implies the need to actively maintain the use of the pricing formula by the Petroleum Regulatory Authority in collaboration with the relevant stakeholders to avoid a disproportionate translation of increase in world energy price to domestic transport cost. In addition, strengthening domestic policy coordination efforts that are conducive to exchange rate stability are imperative, including consistent application of the export proceed repatriation policy in Sierra Leone and the need for a strong export diversification strategy to improve export performance of Sierra Leone. Increased domestic food production in Sierra Leone requires strengthening, as emphasized in Sierra Leone's Feed Salone Programme of the Government of Sierra Leone, as it tends to move with World energy price level.

Keywords: *Inflation, Exchange Rate, Energy Price, Food Price, Instrumental Variables*

JEL Codes: *F31, Q41, E31, C32*

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1. Introduction

Price stability remains a critical objective of central banks around the world. This is rooted in the fact that high inflation rates is a big source of economic disturbance, which can have long-term adverse multi-faceted effects. Hence, high inflation rates are not desired by policymakers, consumers and businesses. It brings uncertainty in decision making. It erodes the purchasing power of income and the value of assets denominated in the domestic currency. In addition, it can translate into increasing exchange depreciation, which creates further uncertainty in the economy. This adversely affects investment decision making and may erode trust in the policymakers, including the ability of central banks to carry out the mandate of price stability. In the extreme case, it can lead to increased dollarization of the economy, increased speculative attack on the currency and complex adverse macroeconomic problems. Both theory and empirical studies have shown that at a certain threshold, inflation can lead to lower economic growth (Khan and Senhadji, 2001).

Global inflation increased following the emergence of the COVID-19 pandemic in 2019, which increased further when the Russian-Ukraine War emerged. Many central banks responded to contain inflation while being cautious not to constrain domestic supply chain. Domestic currency depreciation became a common outcome in many countries. Thus, both inflationary pressure and domestic currency depreciation became sources of macroeconomic uncertainty and great concern for policymakers. Inflation rates and exchange rate depreciation started increasing consistently, though at a slow pace initially, in August 2021, and the slop of the trajectory became steeper after February 2022; thus, introducing an atmosphere of higher macroeconomic uncertainty in terms of higher inflation and Leone depreciation. Throughout 2023, headline inflation was on the increase, though it started falling in October 2023, but it remained high at the end of 2023 and the year 2024 started with a high rate of inflation in spite of following a declining trend. However, 2024 was a year of declining but high inflation rate and exchange rate depreciation was also on a declining trend. The year 2025 experienced a stable exchange rate with low depreciation rates and low inflations rates, with single digit inflation being more common.

During 2020 to 2025, when inflation rate doubled to 26.95% in 2022, from its 2021 value of 11.85%, exchange rate depreciation quadrupled to 24.03%, from its 2021 value of 5.79% and world energy price index increased by more than 50 units in just a year, from 95.4 in 2021 to 152.6 in 2022, while world food price increased by about 18 units. In 2024, world food price index declined by about 10 units, world energy price index declined by about 6 units and exchange rate declined by about 30 percentage points, inflation rate declined by about 17 percentage points from 47.28% in 2023 to 29.82% in 2024. In 2025, exchange rate appreciated relative to its 2023 value, world energy price further declined by about 10 units and world energy price declined by about 5 units, and inflation ate which was 29.82% in 2023 decline to 7.74%. This suggests that as an open economy, exchange rate depreciation, world energy price and world food price play crucial role in Sierra Leone's inflation dynamics. But what is unknown is the relative roles they play. Table 1.1 shows inflation rate, exchange rate depreciation and world energy and food price indices.

Table 1.1: Inflation rate, exchange rate depreciation and world energy and food price indices

Variable	2020	2021	2022	2023	2024	2025
Inflation Rate (%)	13.49	11.85	26.95	47.28	29.82	7.74
Exchange Rate Depreciation (%)	8.37	5.79	24.03	34.51	5.38	-0.30
World Energy Price Index	50.7	95.4	152.6	107.0	101.5	90.1
World Food Price Index	93.7	120.9	138.1	125.4	115.8	109.2

The Bank of Sierra Leone 2019 Act has price stability as a mandate and the Monetary Policy Committee meets on a quarterly basis to adjust the monetary policy rate if necessary and the special deposit facility (SDF) and Special Lending Facility (SLF) rates in an effort to contain inflationary pressure, a task that is based on review of recent economic and financial sector performance and performance going forward.

Sierra Leone imports food and fuel with weights that are strong in the import basket and it does not have control over their international prices. Also, it uses the flexible exchange rate regime. An observation of the data from 2020 to 2025 shows that there is a strong correlation between inflation rate and exchange rate depreciation, with a correlation coefficient of 0.71, while inflation and world energy price has a correlation of 0.44, that with broad money growth is 0.46, with world food price it is 0.46 and all are statistically significant. This calls for a detailed investigation of the relative importance of inflation drivers in Sierra Leone. Hence, the objective of the paper is to investigate the relative roles of exchange rate, world energy price and world food price on inflation rate in Sierra Leone.

While the literature on the dynamics of inflation in developing and low-income countries has grown, emphasis has not been placed on the relative roles of exchange rates, food and energy prices, even though food and energy prices are core external shock sources for a typical net oil and food importing country, like Sierra Leone. Also, studies on inflation in Sierra Leone have not considered the two-way feedback effects of inflation and exchange rate, which is critical because changes in inflation may feed into exchange rate and exchange rate depreciation may also feed into inflation, especially when there is heavy reliance on imported goods. The exchange rate may respond to changes in inflation, thus creating reverse causality and biasing inflation model regression estimates that do not take this feedback effect into consideration.

In Sierra Leone, studies dealing with inflation dynamics are Mansaray et al (2012), Korsu (2014), Danladi (2020), Bangura et al (2021) and Jackson et al (2022), among others. However, they all do not consider the feedback effect between inflation and exchange rate. Also, most of the studies do not consider the roles of energy and food prices in Sierra Leone's inflationary dynamics. This paper contributes to the literature by focusing on the effects of not only exchange rate depreciation but also world food price and world energy price, on Sierra Leone's inflation, in addition to the roles of money supply and interest rates. It also employs the instrumental variable estimation approach to account for the two-way feedback effect between exchange rate depreciation and inflation while accounting for the effect of non-stationary variables on model estimate, which is missing in previous studies on Sierra Leone.

The rest of the paper is structured as follows: Section 2 a brief review of the Literature with focus on Sierra Leone; Section 3 is the methodology; Section 4 is the Data and stylized facts; Section 5 is the empirical results and analysis; and Section 5 is the conclusion.

2. A Brief Review of Literature

Understanding the drivers of inflation in developing countries has attracted significant empirical attentions for a long time, particularly because of the exposure of most of the economies to external shocks and the role of domestic fiscal and monetary constraints. The literature identifies a set of core determinants in theory and practice—broad money growth, world energy prices, world food prices, exchange-rate depreciation, lending rates, and expectation. This section focuses on studies on empirical works in Sierra Leone.

Broad money growth is consistently highlighted as an important domestic determinant of inflation in Sierra Leone. Early empirical studies show that the behaviour of monetary aggregates is closely tied to price formation, particularly during periods of fiscal stress. Mansaray et al (2012), applying a cointegration and error-correction framework using quarterly data from 1990–2010, found that monetary aggregates are cointegrated with the price level and that increases in money supply exert upward pressure on inflation. The results also indicate instability in money demand, which weakens the efficacy of monetary policy as a price-stabilization tool. This conclusion is reinforced by more recent evidence. Jackson et al (2022), using monthly data from 2010–2021 within an ARDL bounds-testing framework, show that growth in currency in circulation significantly contributes to long-run inflation. The study also found that monetary expansion interacts with exchange-rate pressures, amplifying inflationary episodes. Also, Korsu (2014), through a fiscal-monetary simulation model, observed that monetization of fiscal deficits which is consistent with broad money expansion, leads to sustained inflationary pressures. These studies suggest that domestic monetary conditions remain central to inflation dynamics.

Danladi (2020), examining monthly data from 2000–2018, shows that increases in global oil prices significantly raise domestic consumer prices, both directly through higher fuel and transport costs and indirectly through the effect of oil prices on the exchange rate. Also, the study by Bangura et al (2021), which was about modelling oil price volatility and showed that higher crude-oil returns increase the volatility of the Leone–US dollar exchange rate. Since exchange-rate depreciation is a major source of imported inflation, the studies collectively reveal a strong energy-price channel. These findings underscore the vulnerability of inflation outcomes in Sierra Leone to shocks in global oil markets thus strengthening the case for including world energy prices in an inflation model in Sierra Leone.

Food imports constitute a large share of Sierra Leone's consumption basket, particularly rice, making global food-price shocks an important determinant of domestic inflation. Danladi (2020) provides direct evidence that world prices of rice, wheat, and global food indices significantly affect Sierra Leone's consumer prices. The findings indicate that a substantial portion of food-price inflation is transmitted through exchange-rate depreciation, reflecting the country's reliance on imported food. Also, the study by Kallie (2024), revealed that the degree of exchange-rate pass-through (ERPT) is higher for food prices than for non-food items, based on rolling-window ARDL estimations for 2002–2022.

The exchange rate plays a central role in the inflation dynamics of most developing countries on the basis that most are strongly imported, especially for food and energy. In Sierra Leone, Bangura et al (2012), using a Structural Vector Autoregressive (SVAR) model with monthly data for 1996–2011, found strong but incomplete exchange-rate pass-through to domestic prices. The impulse-response results show that exchange-rate depreciation is a key source of imported inflation. Also, the work of Jackson et al (2022) showed that exchange-rate

movements remain a powerful and statistically significant inflation driver even after controlling domestic monetary conditions. The study by Kallie (2024) revealed that ERPT increases during periods of macroeconomic instability, highlighting the non-constant nature of pass-through in Sierra Leone. Also, the work of Barrie (2023) distinguished between the effects of the official and parallel exchange rates, showed that the parallel market rate exhibits a stronger influence on domestic prices due to market segmentation and dollarization than the official rate.

While monetary aggregates and exchange-rate dynamics have shown to have strong inflationary effects for Sierra Leone, the role of lending rate is not strong. Several studies have shown that interest-rate effect is weak in Sierra Leone due to structural and institutional constraints. Mansaray et al (2012) found that instability in money demand and a shallow financial sector reduce the effectiveness of interest-rate tools in influencing inflation. Consistent with this, Jackson et al (2022) observed that while lending rates are included in their ARDL specification, they exert only a limited short-run effect on consumer prices. This weak transmission is attributed to low financial inclusion, dollarization, and the limited responsiveness of private credit to policy-rate changes.

Several studies dealing with inflation dynamics are Mansaray et al (2012), Korsu (2014), Danladi (2020), Bangura et al (2021) and Jackson et al (2022) among others. However, they all do not consider the feedback effect between inflation and exchange rate. Also, most of the studies do not consider the roles of energy and food prices in Sierra Leone's inflationary dynamics. This paper contributes to the literature by focusing on the effects of not only exchange rate depreciation but also world food prices and world energy prices on Sierra Leone's inflation and by using the instrumental variable estimation approach to account for the two-way feedback effect simultaneously with accounting for the role of non-stationarity of variables. Table 2.1 shows a summary of the survey of the empirical literature on inflation determinants in Sierra Leone.

Table 2.1: Survey of Empirical Studies on Inflation Determinants in Sierra Leone

Author (s) & year	Title of Paper	Data Period & Frequency	Methodology	Key Findings
Bangura, Caulker &Pessima (2012)	Exchange Rate Pass-Through to Inflation in Sierra Leone: A Structural Vector Autoregressive Approach	Monthly, 1996–2011	SVAR with Cholesky identification	Exchange rate depreciation significantly affects inflation; pass-through is incomplete but substantial; imported inflation is a major channel; monetary aggregates also influence prices.
Jackson, Kamara & Kamara (2022)	Determinants of Inflation in Sierra Leone	Monthly, 2010–2021	ARDL bounds testing + ECM	Exchange rate depreciation, broad money growth, fiscal deficits, and GDP growth significantly drive inflation; long-run effects dominate short-run; inflation largely cost-push.
Barrie (2023)	Estimating the Impact of Official and Parallel Exchange Rates on Inflation in Sierra Leone	Monthly, 2005–2022	VAR + FEVD + Granger causality	Both official and parallel exchange rates affect inflation; parallel rate has stronger impact due to market segmentation; exchange rate premiums amplify inflation volatility.
Danladi (2020)	International Commodity Prices and Inflation Dynamics in Sierra Leone	Monthly, 2000–2018	ARDL + SVECM	World food and fuel prices significantly transmit to domestic inflation; exchange rate mediates much of the pass-through; domestic supply shocks are less influential.
Tamuke & Kamara (2024)	Forecasting Exchange Rate Volatility and Its Impact on Inflation in Sierra Leone: A GARCH-MIDAS Approach	Daily (exchange rate) + monthly CPI	GARCH-MIDAS	Exchange rate volatility strongly predicts inflation; low-frequency volatility has more persistent effects than short-term shocks; inflation influenced by uncertainty in FX market.
Kallie (2024)	Estimating Exchange Rate Pass-Through to Consumer Prices in Sierra Leone	Monthly, 2002–2022	ARDL + Rolling-window estimation	Exchange rate pass-through is time-varying; higher for food than non-food items; sensitivity of inflation to FX shocks increases during macro instability.
Kamara (2024)	Dynamics of Exchange Rates, Inflation and Trade Balance in Sierra Leone	Quarterly, 2005–2023	VECM + Impulse response	Inflation responds strongly to exchange rate shocks; trade balance deterioration often precedes inflation; external shocks dominate domestic determinants.
Korsu (2014)	Inflationary Effects of Fiscal Deficits in Sierra Leone: A Simulation Approach	Annual, 1980–2011	Structural simulations + fiscal-monetary framework	Fiscal deficits and monetization contribute significantly to inflation; exchange rate depreciation magnifies the effect; dual fiscal–external pressures on inflation.
Mansaray & Swaray (2012)	Financial Liberalization, Monetary Policy and Money Demand in Sierra Leone	Quarterly, 1990–2010	Cointegration + ECM	Money demand is unstable; monetary policy transmission weak; inflation responds more to exchange rate changes than interest rates; structural issues in monetary control.
Jackson, Barrie & Pessima (2021–2023)	Exchange Rate, Inflation and Banking Sector Interlinkages in Sierra Leone	Panel + macro, 2005–2020	Panel regression + VAR	Exchange rate depreciation worsens inflation and banking sector performance; inflation volatility linked to currency depreciation; FX shocks dominate domestic monetary factors.

3. Methodology

3.1. Specification of the Inflation Model

The inflation model is based on the Purchasing Power Parity (PPP) and the Quantity Theory of Money. This is because the combination of these to theories gives room for exchange rate, foreign price level and domestic money supply as determinants of inflation, thus reflecting the role of the Monetary Authorities, through domestic money supply, and exchange rate and foreign price level in the inflationary dynamic process. The Power Parity (PPP) posits that domestic inflation is driven by exchange rate and foreign price level while the Quantity Theory of Money posits that inflation is due to increase in money growth. Equation (3.1) gives the PPP.

Based on the PPP, domestic price level (P^d) is equal to the product of exchange rate € and foreign price level (P^f). That is:

$P=e.p^f$ ..... (3.1)

In growth form, it is given as:

$$\frac{\Delta P}{Pt-1} = \frac{\Delta e}{et-1} + \frac{\Delta P^f}{P^f t-1} \text{..... (3.2)}$$

Where, $\frac{\Delta P}{Pt-1} = inflation\ rate$, $\frac{\Delta e}{e_{t-1}}$= percentage change in exchange rate, which is directly related to the depreciation of the local currency and $\frac{\Delta P^f}{P_{t-1}}$ i= growth of foreign price level.

Equation (3.2) gives the Quantity Theory.

$M_tV_t = P_tY_t$..... (3.3)

Where, M = Money Supply, V = Velocity of Circulation of a unit of money, P = Price level, Y = Output in constant prices (real output). Equation (3.3) can be written in growth form as equation (3.4):

$$\frac{\Delta Mt}{Mt-1} + \frac{\Delta Vt}{Vt-1} = \frac{\Delta Pt}{Pt-1} + \frac{\Delta Yt}{Yt-1} \text{..... (3.4)}$$

Where, $\frac{\Delta Mt}{Mt-1}$= money growth, $\frac{\Delta Vt}{Vt-1}$= growth in the velocity of circulation of a unit of money, $\frac{\Delta Pt}{Pt-1}$= growth in price level and $\frac{\Delta Yt}{Yt-1}$= growth in output in constant prices.

Considering velocity of circulation of money, which is the average number of times a unit of money changes hand, to be fixed and solving for $\frac{\Delta Pt}{Pt-1}$ gives equation (3.5).

$$\frac{\Delta Pt}{Pt-1} = \frac{\Delta Mt}{Mt-1} - \frac{\Delta Yt}{Yt-1} \text{..... (3.5)}$$

Equation (3.5) implies that inflation rate depends on the difference between money growth and growth of outputs which implies that in the short run, when output is fixed, due to structural constraints (example from one month to another), inflation is explained by money growth.

By way of the theoretical framework extension to a theoretical model, lending rate is the price of credit and banks can create money by accepting deposits and lending to customers, increase in lending rate is expected to dampen money creation and hence reduce the growth of broad money and inflation also reduces. This negative effect is the indirect effect of lending rate on inflation. However, through cost push inflation mechanism, increase in lending rate acts as increase in the cost of production (cost of capital). This cost is passed to consumers through increase in final products. Thus, increase in lending rate can lead to an increase inflation rate through the direct effect. The final impact on inflation therefore depends on which effect is greater.

Central Banks that use adjustment of policy rates to curb inflation conceive the indirect effect to be greater than the direct effect and therefore increase the policy rate during the inflationary pressures so lending rate can adjust upwards for a final dis-inflationary effect. Sierra Leone falls in this category, though it also used a monetary aggregate framework for the conduct of monetary policy with reserve money as the operational target and broad money as the intermediate target. Thus, the inflation model is determined shown in equation (3.6)

$$\frac{\Delta P}{P_t} = f\left(\frac{\Delta M_t}{M_{t-1}}, \frac{\Delta Y_t}{Y_{t-1}}, \frac{\Delta e}{e_{t-1}}, \frac{\Delta P^f}{P^f{}_{t-1}}\right) \text{..... (3.6)}$$

In Sierra Leone, food and energy are the major components of the import basket, food accounts for about 25 percent, crude materials account for about 2.1percent and mineral fuels and

lubricant account for about 16 percent. Given that food and energy are necessary goods and not luxury, we use world energy price index and world food price index to capture foreign price level and equation (3.6) is extended to equation (3.7)

$$\frac{\Delta P}{P_t} = f\left(\frac{\Delta M}{M_{t-1}}, EXR\_DEP, P^{food}, P^{energy}\right) \ldots\ldots\ldots\ldots\ldots (3.7)$$

In linear dynamic form, equation (3.7) is given as in (3.8)

$$Inf_t = \sigma + \sum_{i=0}^{P_t} \beta_i\, Mg_{t-i} + \sum_{i=0}^{P_2} \lambda_i\, EXR_{DEP_{t-1}} + \sum_{i=0}^{P_3} \alpha_i\, P_{t-i}{}^{food} + \sum_{i=0}^{P_4} \delta_i\, P_{t-i}{}^{energy} + \sum_{i=0}^{P_5} \mu_i\, LR_{t-i} + \sum_{i=1}^{q} \rho_i\, Inf_{+t-i} \cup_t \quad (3.8)$$

Where INF is inflation rate, Mg is growth of broad money, EXR_DEP is exchange rate depreciation, P^{food} is world food price index, P^{energy} is world energy price index, ∪is the disturbance term and t is time subscript. The disturbance term is considered to be non-spherical in the sense that it has a zero mean, constant variance, serially uncorrelated and normally distributed.

In Table 3.1 the expected signs of model parameters are presented. The expected signs of the variables in equation (3.8) are as in Table 3.1.

Table 3.1: Expected signs of Model Variables

Variable	**Contemporaneous Parameter (Impact)**	**Sign**	**Dynamic Impact (Sum of Parameters)**	**Sign**
Money Growth	β_0	Positive	$\sum \beta_i$	Positive
Exchange Rate Depreciation	λ_0	Positive	$\sum \lambda_i$	Positive
Imported Food Price	α_0	Positive	$\sum \alpha_i$	Positive
Energy Price	δ_0	Positive	$\sum \delta_i$	Positive
Lending Rate	μ_0	Positive or Negative	$\sum \mu_i$	Positive or Negative
Persistence	ρ_0	Positive	$\sum \rho_i$	Positive

Money supply growth increases liquidity, thereby boosting aggregate demand. This excess demand pushes prices upward if the supply side does not respond adequately, which causes inflation. An increase in exchange rate depreciation leads to higher inflation because it increases the cost of imported goods in domestic prices, thus raising the price level. Hence, through the transmission of exchange rate depreciation to domestic prices, inflationary pressures increase from increase in exchange rate depreciation. The price of imported food is expected to have a positive effect on inflation because food is a major component of the overall price level, accounting for a significant portion of household spending, especially in developing countries. Hence, when food prices rise, the general price level also increases, leading to higher inflation. This is more acute in jurisdictions with high inelastic demand for food. However, if domestic food production can favourably respond to increase in prices of imported food, this effect could be very low.

Energy price has a positive impact on inflation because energy is a critical input in production and consumption (for example transportation and household use). When energy prices rise, cost of production and distribution of goods and services increases. This translates into increase in inflation.

Lending rate affects inflation by influencing borrowing costs upwards, thereby reducing aggregate demand in the economy because higher lending rate makes loans more expensive, discouraging spending and investment, thus reducing inflationary pressures. On the other hand, the effect of higher lending rate can be inflationary because higher lending rate translates into higher borrowing cost and producers shift the burden to the consumers by raising the price of final products, thus leading to increase in inflation. Also, past inflation shapes expectations and influences how businesses and workers set prices and wages. When inflation is high, firms anticipate further increases and raise prices accordingly, while workers demand higher wages to keep up. In addition, expectation of higher prices can lead to more spending in order to avoid buying at higher prices later. This pushes aggregate demand up, and under a constrained supply, price level increase. This behaviour creates a feedback effect that sustains inflation over time, leading to inflation persistence.

3.2. Estimation Technique

Time series regression of non-stationery variables leads to misleading inferences when appropriate transformation is not done before the application of the Ordinary least Squares (OLS), despite it being the best linear unbiased estimator (BLUE). Failure to transform appropriately leads to high R^2 and statistically significant t-statistic and F-statistic even when the variables are not related in reality but are related only due to the fact that they are all trending (existence of common trend). Thus, the risk of committing a Type I error (rejecting the null hypothesis of no significant relationship wrongly) is high in this case. Also, in this circumstance, tests of significance and coefficient estimates are not valid because t-test and F-test assume that the variables are stationary.

In light of averting the problem of the existence of non-stationarity, we tested each variable for stationarity. The Dickey-Fuller (GLS) test was applied, as it outperforms the original Dickey-Fuller test. Moreover, given that structural break in a variable may lead to the conclusion that a variable is not stationary when in fact it is stationary, we augmented the test with series of stationarity tests that account for structural break. These are the Zivot-Andrews unit root test, the Perron Vogelsang unit root test and the Clement-Montane-Reyes unit root test. The Zivot-Andrews test considers break in the mean and / or trend and we applied it leaving allowing for break in both trend and intercept. However, it is on silent of whether the break is gradual or immediate. Hence, it may not notice a gradual break. In light of this, we supported it with the Perron-Vogelsang unit root test, which accounts for both immediate and gradual breaks. It however tests for a single break. Thus, if there are two breaks, we may fail to reject the null of unit root (not stationary) when in fact there is no unit root. As the Clement-Montane-Reyes test takes the possibility of two breaks into account we also used it.

Following the tests for stationarity, the inflation model is estimated taking the unit root test results into consideration, by doing the appropriate transformation to ensure any non-stationary variable becomes stationary through differencing.

The inflation model was then estimated by searching for a parsimonious model from estimation of an over-parameterized model to a preferred parsimonious model. The instrumental variable estimation was done for the model estimation. The use of instrumental variable technique was

on the basis that inflation and exchange rate have a bi-contemporaneous causality (not Granger causality). For example, increased exchange rate depreciation can impact domestic prices through the prices of imported goods. Also, increased inflation can lead to increased macroeconomic instability and uncertainty. This can further lead to increased demand for foreign currency due to flight to foreign currency holdings in order to protect the value of their money balances. The situation can further be compounded when speculative activities set in which leads to further depreciation of the domestic currency. In light of this, the application of the Ordinary Least Squares (OLS) becomes inferior as exchange rate becomes an endogenous explanatory variable rather than a truly exogenous variable, as the error term in the inflation model is correlated with the exchange rate variable. This makes OLS estimators to be biased.

A maximum lag length of 2 was used in the initial model. This was meant to exploit the advantage of higher lag length while balancing it with higher degrees of freedom. In addition, a general model is estimated with two lags of each variable and the parsimonious model with only significant variables is obtained by deleting insignificant variables one by one. This model reduction was done by estimating with the instrumental variable (IV) technique where exchange rate depreciation was instrumented with first to three lags of each variable in the specified model (which are exchange rate depreciation, world energy price index, world food price index, broad money growth, lending rate and inflation) and the current values of all truly exogenous variables (world energy price index, world food price index, broad money growth, lending rate).Model diagnostics tests were then done, including tests for serial correlation, tests for endogeneity and instrument validity.

The parsimonious model was also estimated in standardized form to obtain the beta coefficients. This is done to determine the relative importance of the model variables as all beta coefficients are interpreted in terms of standard error instead of in the unit of measurement of the variables.

4. Data and Stylised Facts

4.1 The Data Sources and Description

The study data is monthly data from 2020 to 2024, and the choice of the period is to focus the study on the period of strong international supply chain disruption with increasing or high inflationary pressures in Sierra Leone. Table 4.1 gives the description of the data and the sources.

Table 4.1: Data Description and Sources

Variable	Symbol	Description	Source
Inflation Rate	Inf	Percentage change in year-on-year consumer price index	Statistics Sierra Leone
Broad Money Growth	Mg	Year-on-year percentage change in broad money growth	Bank of Sierra Leone Datawarehouse
Exchange Rate Depreciation	EXR_DEP	Year-on-year percentage change in exchange rate, with exchange rate defined as USD/NLe	Bank of Sierra Leone Datawarehouse
World Food Price	P^{food}	World Food Price Index	World Bank Database (Pink Sheet)
World Energy Price	P^{energy}	World Energy Price Index	World Bank Database (Pink Sheet)
Lending Rate	LR	Average Lending Rate	Bank of Sierra Leone Datawarehouse

4.2. Stylised Facts

(i) Simple Correlation Analysis

Table 4.2 shows the simple correlation matrix, with the respective p-values for significance of the correlation coefficients in parentheses, while Figure 4.1 shows the movements over time in inflation and each theoretical determinant. The p-value is the probability of committing a type 1 error when the null hypothesis of no significant correlation is rejected. Thus, at the 5% (or 1%) level of significance, if it is higher than 5% (or 1%) we fail to reject the null hypothesis of no correlation at the 5% (1%) level of significance.

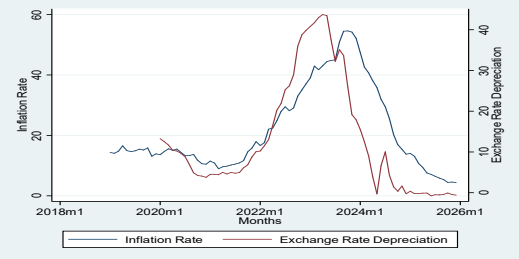
Table 4.2: Simple Correlation Matrix of Model Variables

	Inflation Rate	Exchange Rate Depreciation	World Energy Price	Broad Money Growth	World Food Price
Exchange Rate Depreciation	0.761* (0.000)				
world energy price	0.433 * (0.000)	0.439* (0.001)			
Broad Money Growth	0.527 * (0.003)	0.623* (0.000)	0.104 (0.383)		
world food price	0.449* (0.000)	0.473* (0.000)	0.837* (0.000)	0.365* (0.002)	
Lending Rate	-0.265 (0.015)	-0.407* (0.000)	-0.254* (0.020)	-0.3348 (0.004)	-0.245* (0.025)

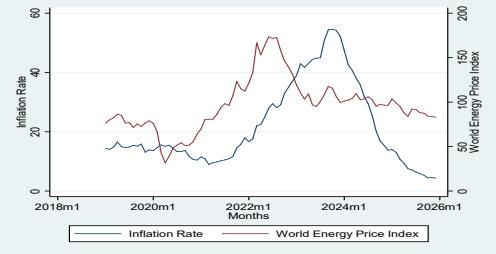
The correlation matrix shows that the correlation coefficient between inflation and exchange rate depreciation is 0.76 and is significant at the 1 percent level since the p-value is lower than 1 percent (0.000). In addition, world energy price, broad money growth and world food price are positively correlated with inflation rate, all having p-values showing that they are significant at the one percent level of significance. Specifically, the correlation between inflation rate and world energy price, growth of broad money and world food price are 0.43, 0.53 and 0.45, respectively. The correlation between lending rate and inflation is negative, at -0.265, and it is significant with a p-value of 0.015. The correlations suggest that higher inflation in Sierra Leone is explained by higher exchange rate depreciation, world energy price, world food price and growth of broad, while associated with lower lending rate. Moreover, exchange rate depreciation exerts the greatest influence followed by growth of broad money and while world energy price and world food price exert almost the same influence and lending rate carries the least association. However, these correlations do not imply causality.

Figure 4.1: Line Plots of Inflation and the Theoretical Determinants

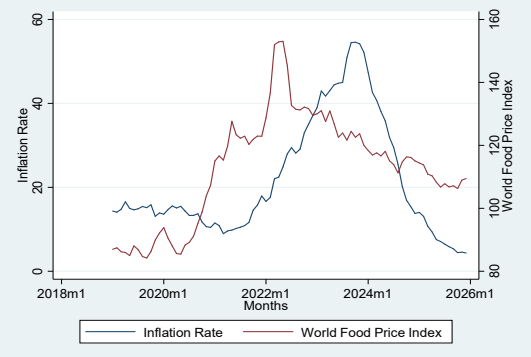
1.Inflation and Exchange Rate Depreciation



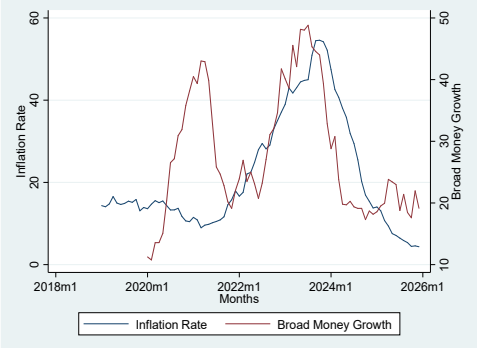
2. Inflation and World Energy Price



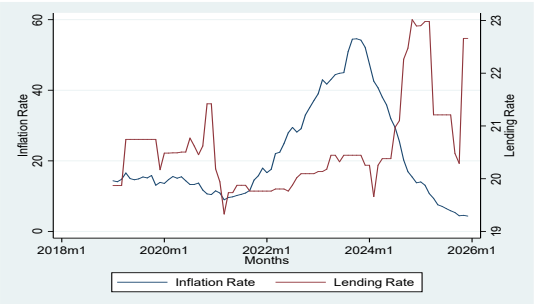
3. Inflation and World Food Price



4. Inflation and Money Growth



5. Inflation and Lending Rate



Considering the correlations among the theoretical determinants of inflation, the correlation coefficients are generally low, with the exception of that between world food price and world energy price, at 0.84 and that between broad money growth and exchange rate depreciation, at 0.623, both of which are significant at the 1 percent level. Exchange rate depreciation and world energy price, and exchange rate depreciation and world food price have correlation coefficients of 0.44 and 0.47 respectively, suggesting that world energy price and world food price tend to move together with exchange rate depreciation but not as strong as that between world food price and world energy price and that between money growth and exchange rate depreciation.

(i) Partial Correlation Analysis

Table 4.3 shows the partial correlations of inflation and the theoretical determinants. It shows the correlation between inflation and each theoretical determinant after controlling for all the determinants. It shows that the correlation between exchange rate depreciation and inflation after controlling for other variables is positive, at 0.530 and that with inflation and money growth and world energy price are 0.178 and 0.155, respectively. For world food price and inflation, the correlation is -0.10 while for lending rate it is 0.066. However, it is only exchange rate depreciation that has a significant partial correlation, at the one percent level.

While partial correlation measures the direction of effect, partial correlation squared measures the relative importance. It shows that exchange rate depreciation has the highest partial correlation squared, with partial correlation squared of 0.28. Money growth follows exchange rate depreciation with partial correlation squared of 0.032, followed by world energy price with 0.024 and world food price with 0.010, while lending rate has the least, with 0.004. Thus, the partial correlation coefficients reveal that exchange rate depreciation has the greatest effect on inflation rate in Sierra Leone, when the other model variables are controlled for. World energy price and money growth follow, with world food price and lending rate being the least contributors and are not significant.

Table 4.3: Partial Correlation Coefficients of Model Variables

Variable	Partial Correlation	Semi Partial Correlation	Partial Correlation Squared	Semi Partial Correlation Squared	P-Value for Significance
Exchange Rate Depreciation	0.530	0.395	0.280	0.156	**0.000**
World Energy Price	0.155	0.099	0.024	0.010	**0.208**
Broad Money Growth	0.178	0.114	0.032	0.013	**0.147**
World Food Price	-0.100	-0.064	0.010	0.004	**0.417**
Lending Rates	0.066	0.042	0.004	0.002	**0.596**

5. Empirical Results and Analysis

(i) Descriptive Statistics of Variables

Table 5.1 shows the descriptive statistics of model variables. It shows that for all the variables, with the exception of world food price, the mean values are more than the median values. That means that there are high extreme values that drive the distributions to having heavy tails on the right, leading to positive skewness, implying that there are more values that are lower than the mean values for these variables. Thus, during the period January 2020 to December 2025, for most of the time inflation rate was less than the mean of 21.71 percent and 50 percent of the time, inflation rate was above 15.29 percent as the median inflation rate is 15.29 percent.

Exchange rate depreciation was more than half of the time less than 15.79 percent and for half of the time, it was more than 13.73 percent. For broad money growth, as the mean is 29.23 percent, with a median of 26.99 percent, most of the time, the growth of broad money was lower than 27.77 percent while for half of the time it was less more than 23.88 percent. For lending rate, the mean is 20.59 percent, and the median is 20.45 percent, which implies that about half of the data point are above 20.45 and more than half of them are below 20.6.

World energy price has a mean of 96.77 and a median of 95.85, implying that most of the world energy price values are below 97.89 while 50 percent are above 97.29. For world food price, with a mean of 112.8 and median of 115.2, most of the observations are above the mean of 112.8 and half of them are above 115.2.

Table 5.1: Descriptive Statistics of Model Variables

VARIABLES	**Mean**	**Median**	**Minimum**	**Maximum**	**Standard Deviation**	**Coefficient of Variation**
Inflation rate	21.71	15.29	4.35	54.59	14.04	0.65
World Energy Price Index	96.77	95.85	31.63	173.5	30.40	0.31
World food price Index	112.8	115.21	84.21	153.1	17.49	0.16
Lending Rate	20.59	20.45	19.33	23.02	0.88	0.04
Exchange Rate Depreciation	15.79	13.73	8.53	22.80	5.93	0.38
Broad Money Growth	27.77	23.88	10.76	48.82	10.21	0.37

(ii) Stationarity Test Results

A variable that is stationary does so either along the mean or a trend line. Thus, line plots of model variables were obtained to determine whether the DF-GLS test needs to be done with intercept only or both intercept and trend in in the auxiliary regression. Appendix Figure 1 shows the line plots of all variables, which shows that all the variables have stochastic trend (and not deterministic trend). Thus, the DF-GLS tests were done with only intercept. Table 5.2 shows the summary of the conclusion for each variable across the unit root tests, which are the DF-GLS test, Zivot-Andrews unit root test (a structural break incorporating test), Perron-Vogelsang unit root test (also a structural break unit root test and the Clemente-Montanes-Reyes unit root test (a double structural break unit root). It shows that t broad money growth is stationary in level while all the other variables are stationary after first differencing. The order of integration is the least order across all the tests. This is based on the fact that when a variable is stationary without accounting for structural break, there is no point in testing it with a structural break method since the harm structural break causes is to make the variable appear non-stationary even it is stationary.

Table 5.2: Combined Unit Root Test Results

Variable	Order of Integration from DF-GLS	Order of Integration from PV	Order of Integration from CMR	Order of Integration from ZA	Conclusion from all the three results
Inflation Rate	I(1)	I(2)	I(1)	I(1)	I(1)
Broad Money Growth	I(0)	I(1)	I(2)	I(1)	I(0)
World Energy Price	I(1)	I(1)	I(1)	I(1)	I(1)
world food price	I(1)	I(1)	I(1)	I(1)	I(1)
Lending Rate	I(1)	I(1)	I(1)	I(1)	I(1)
Exchange Rate Depreciation	I(K)	I(1)	I(1)	I(2)	I(1)

Note: 1. I(K) means series is not stationary after second difference

Appendix Tables 1 to 4 show the results of the various unit root tests. The test results reveal the following:

(i) Thet Dickey-Fuller Generalised Least Squares (DF-GLS) test results: broad money growth is stationary around its mean-it is integrated of order zero while exchange rate depreciation has a higher order of integration with an order that is more than two. All the other variables are stationary after first differencing. That is, they are integrated of order one.

(ii) The Zivot-Andrews unit root test result: all model variables are integrated of order one, with the exception of exchange rate depreciation, which is integrated of order two.

(iii) Based on the Perron-Vogelsang unit root test: inflation rate is stationary after second differencing. That is, it is integrated of order two while all the order variables are stationary after first differencing- integrated of order one.

(iv) The Clemente-Montanes-Reyes tests: all the variables are stationary after first differencing. That is, they are integrated of order one, with the exception of broad money growth, which is stationary after second differencing- integrated of order two.

(iii) Model Estimation Results

We consider inflation and exchange rate depreciation to have a two-way causality and therefore estimated the model with instrumental variable (IV) technique. However, all non-stationary variables were transformed by appropriate differencing for stationarity in order to protect estimates from spurious regression. All the exogenous variables and their first three lags were used as instruments for exchange rate depreciation.

While theory dictated choice of model variables, the actual modelling process was supported by exploratory data analysis (EDA), driven by the stylized facts. Among the explanatory variables, the correlation between world energy price and world food price is found to be high 0.84, which is the highest among the explanatory variables and is significant at the 1 percent level. The other pairs of explanatory variables have low correlations, though money growth and exchange rate depreciation have a significant correlation coefficient of 0.62. Hence, in order to guide against the adverse impact of strong correlation among explanatory variables, three versions of the model were estimated, which are Model 1, Model 2 and Model 3. Table 4.3 shows the results of the model estimates. Model 1 is the parsimonious model from the exclusion of world food price. Model 2 is the parsimonious model from the exclusion of world energy price while Model 3 is the parsimonious model from the inclusion of both world food price and world energy price in the estimation. In each of these three cases, an over parameterized model was first estimated, which was then reduced to a parsimonious model by

dropping insignificant variables one after the other, based on the size of the p-value, in the spirit of the Hendry's general-to-specific modelling approach (Hendry 1995).

In all the three versions of the model estimates, the Hausman test for IV estimator versus OLS estimator shows that the IV estimator is preferred (test result shown at the bottom of Table 5.3). All the three models carry the same sign and significance implications, with the exception of the observation that in Model 1 and 2, lending rate (second lag) remains insignificant but is significant in Model 3. Observation of the p-values of world energy and world food prices across models show that Model 3 has lower p-values for them, and in general, across other variables the model has lower p-values, implying that its coefficient estimates have lower standard errors, which implies it has more efficient estimates of parameter. Thus, Model 3 is the final parsimonious preferred congruent model of inflation determinants in Sierra Leone.

In order to determine the relative importance of the variables in the final model (Model 3), it was then estimated using the standardized values of all the variables, to obtain the beta coefficient. Model 4 presents Model 3 in its beta coefficient form.

Table 4.3: The Estimated Inflation Model Results

Variables	**Model 1 (World food price excluded)**	**Model 2 (World energy price excluded)**	**Model 3 (Both world energy and food prices included)**	**Model 4 (Beta coefficient Estimates of Model 3)**
Inflation Rate (lag 1)	0.465*** (0.000)	0.442*** (0.000)	0.485*** (0.000)	0.485*** (0.000)
Exchange Rate Depreciation	0.364*** (0.000)	0.388*** (0.000)	0.346*** (0.000)	0.339*** (0.000)
World Energy Price	0.066** (0.008)		0.075*** (0.003)	0.178* (0.003)
Broad Money Growth (lag 1)	0.079*** (0.001)	0.077*** (0.002)	0.079*** (0.001)	0.061*** (0.001)
Lending Rate (lag 2)	0.888** (0.038)	0.672 (0.144)	0.952** (0.005)	0.048** (0.005)
World Food Price		-0.012 (0.796)	-0.059 (0.220)	-0.081 (0.220)
Constant	-2.459*** (0.001)	-2.292*** (0.004)	-2.450*** (0.001)	-0.010 (0.510)
Observations	56	56	56	56
R-squared	0.578	0.519	0.590	0.590
Adjusted R-Squared	0.464	0.529	0.460	0.460
Wald Chi-sq(Prob)	73.41(0.000)	55.18(0.000)	74.78(0.000)	74.78(0.000)
Overid: chi-sq stat. (prob)	6.476(0.594)	4.941(0.667)	7.818(0.647)	7.818(0.647)
Test for exogeneity				
-Wu-Hausman stat. (prob)	0.647(0.425)	1.068(0.307)	0.343(0.561)	0.343(0.561)
-Robust score (prob)	0.410(0.522)	0.729(0.393)	0.233(0.629)	0.233(0.629)
OLS vs IV test				
Hausman: chi-sq(prob)	12.51(0.000)	5.22(0.022)	17.81(0.000)	
	Test residual serial correlation			
Cumby-Huizinga test: chi-sq(prob)	0.156(0.693)	0.059(0.808)	0.650(0.420)	

P-Values in Parentheses ***p<0.01, **p<0.05, p<0.1

The result of the preferred model of inflation shows that exchange rate depreciation has a positive and significant contemporaneous effect (significant at the one percent level) on inflation in Sierra Leone. That is when exchange rate depreciation increases in a given month, inflation rate increases in the same month. The result also shows that world energy price has a significant positive contemporaneous effect on inflation rate, significant at one percent level. However, while exchange rate and world energy price have contemporaneous positive effects on inflation, money growth and lending rate have delayed positive effects, with money growth having one-month lag effect and lending rate having two-month lag effect. Hence, for exchange rate depreciation and world energy price, once they increase their effects are transmitted in the same month, suggesting the need for domestic policy actions to constrain this immediate transmission. However, world food price does not have significant effect on inflation rate in Sierra Leone, suggesting that domestic supply chain for food in Sierra Leone tend to improve as a response to increase in world food price and there is often a favourable shift in demand from imported food to domestic food when an increase in world food price is observed.

Growth of broad money has a significant positive effect on inflation, but the impact comes with one-month lag (significant at one percent level), and lending rate also has a significant positive effect on inflation rate in Sierra Leone, but the impact comes with a two-month lag. Thus, it is the variable for which inflation has the longest response time. This positive effect of lending rate on inflation implies that as lending rate is cost of borrowing, when it increases, borrowers pass the cost to the price of final products, leading to higher prices. It is important to note that in multiple regression, every variable represents its independent effect on the dependent variable. Therefore, this positive effect of lending rate on inflation reflects the direct and independent effect of lending rate on inflation but not its impact through reduced bank borrowing and its subsequent reduced money supply effect, which can have its attendant final effect on inflation.

The result suggests that as money growth has a positive effect on inflation and lending rate also has a positive effect, the final effect of monetary policy actions that increase the monetary policy rate (MPR) to curb inflationary pressures depends critically on how credit to the private sector responds to changes in lending rate and how money supply also responds to the change in credit to the private sector. The combined effect of this volume effect (demand side) and the cost-of- borrowing effect determines the final effect of lending rate on inflation. However, the model captures only the independent effect of lending rate on inflation, as money growth also appears in the model.

In addition, as the one-period lag of inflation is significant with a positive coefficient (0.49). Hence, there is inflation persistence in Sierra Leone, though the persistent coefficient is less than 50 percent. This means that when inflation rate increases in a given month by one percentage point, it increases in the following month by 0.49 percentage point, driven by expectation of higher inflation.

In terms of relative importance, judged by the beta coefficient estimates (Model 4), inflation persistence however has the strongest impact, with a beta coefficient of 0.49, suggesting a strong role for public expectation in the inflationary dynamics of Sierra Leone. Among the other explanatory variables, exchange rate depreciation has the greatest impact, with a beta coefficient of 0.34, which is followed by world energy price, with a beta coefficient of 0.18, while money growth and lending rate follow in descending order of impact, with beta coefficients of 0.06 and 0.05, respectively.

Model diagnostic tests reveal that the instruments are valid as indicated by a p-value of 0.647 for the chi-sq. statistics related to instrument validity (over identifying restrictions). Also, the

Wu-Hausman test for exogeneity of instruments shows that the instruments are valid, with a p-value of 0.561. The result is consistent with the robust score test with a p-value of 0.629. In addition, the Hausman test for OLS and instrumental variables shows that for all three versions of the model, the IV estimate is preferred to an OLS estimate, confirming the need to take the feedback effect of exchange rate and inflation into consideration in modelling inflation rate for Sierra Leone. In addition, the Cumby-Huizing a serial correlation test, which is more appropriate than the Breusch-Godfrey LM test for serial correlation in the case of IV estimators, shows that the model is free from serial correlation.

6. Conclusion

The study investigates the roles of exchange rate, world energy price and world food price on inflation in Sierra Leone with data from January 2020 to December 2025. By noting that inflation and exchange rate can have a two-way contemporaneous causal relationship and following tests for stationary of all variables to avoid spurious relationship, the instrumental variable (IV) estimator is applied by accounting for non-stationary of some model variables.

A parsimonious model is obtained from an over-parameterized model of inflation through the Hendry's general-to-specific framework. The result shows that inflation rate during 2020 to 2024 was determined significantly by its own persistence, Leone depreciation, world energy price, growth of money supply and lending rate, while world food price was not found to be significant. In addition, based on beta coefficients, exchange rate has the largest and most immediate impact (same month impact), followed by world energy price impact, which also has same month impact, as exchange rate depreciation. Money growth and lending rate follow on this magnitude, in descending order of magnitude.

Based on the results, strengthening domestic policy coordination efforts that are conducive to exchange rate stability is imperative, including continued effort in strengthening the application and monitoring of the export proceed repatriation policy in Sierra Leone and the need for a strong export diversification strategy to improve export performance of Sierra Leone, which requires a wider stakeholder effort, across specific and relevant Ministries, Departments and Agencies (MDAs

Moreover, as energy price has a significant positive effect on inflation rate with same month impact, it is useful to maintain active use of the pricing formula used by the Petroleum Regulatory Agency (PRA) in collaboration with the relevant stakeholders in order to manage a disproportionate transfer of increased energy price to transport cost and inflation rate. As World Food price does not have a significant impact on domestic inflation rate, efforts to improve domestic supply chain for food needs to be sustained in order to reduce the share of imported food in total import. In addition, consistent active use of the various instruments of the monetary targeting framework of the Bank of Sierra Leone to slow the growth of reserve money, which is the operational target, and hence slow the growth of broad money should be complemented with raising monetary policy rate in periods that require containing inflationary pressures. This ensures that the two actions are mutually reinforcing as money growth has a positive effect with one-month lag on inflation rate in Sierra Leone. This requires continued strengthening of the monetary and fiscal policy coordination efforts of the Fiscal Authorities and the Bank of Sierra Leone. Also, as world food price index and world energy price index are highly correlated, increased domestic food production in Sierra Leone requires strengthening, as emphasized in Sierra Leone's Feed Salone Programme of the Government of Sierra Leone.

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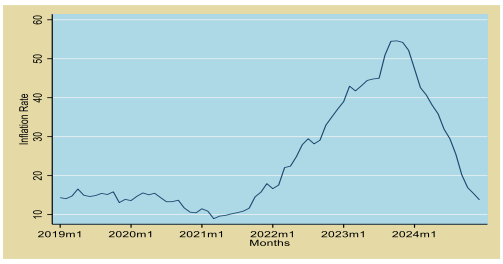
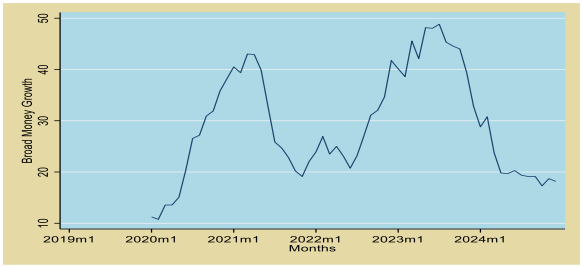
APPENDIX

Appendix Figure 1: Line Plot of Model Variables

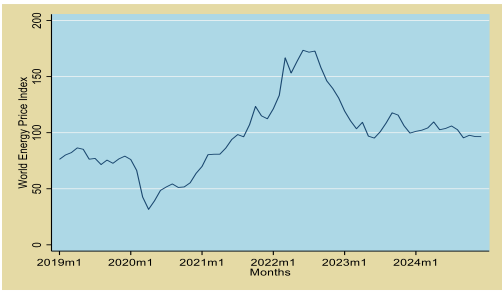
Panel A: Inflation Rate



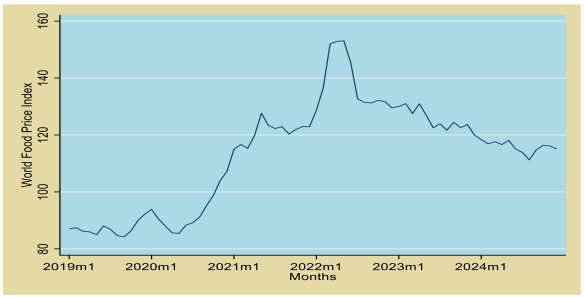
Panel B: Broad Money Growth



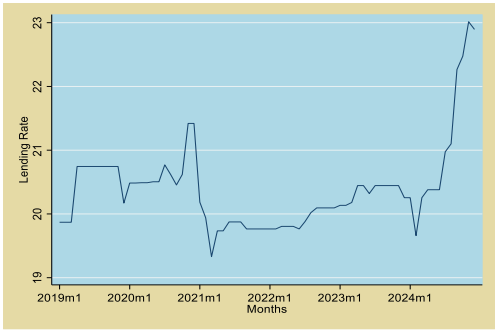
Panel C: World Energy Price Index



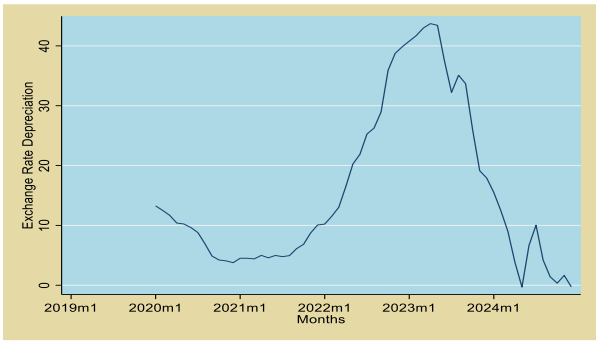
Panel D: world food price Index



Panel E: Lending Rate



Panel F: Exchange Rate Depreciation



Appendix Table 1: Dickey-Generalised Least Squares (DF-GLS) Unit Root Test Results

Variable		Deterministic Component	Lag	Test Statistics	Conclusion
Inflation Rate	L	Constant	1	-1.134	I(1)
	1D		1	-3.054**	
Broad Money Growth	L	Constant	2	-3.129**	I(0)
World Energy Price	L	Constant	1	-1.294	I(1)
	1D		1	-4.542**	
world food price	L	Constant	1	-0.969	I(1)
	1D		1	-4.382**	
Lending Rate	L	Constant	1	-0.130	I(1)
	1D		1	-4.785**	
Exchange Rate Depreciation	L	Constant	4	-0.164	I(K)
	1D		4	-0.503	
	2D		4	-0.138	
Food Inflation	L	Constant	1	-1.077	I(1)
	1D		1	-3.629	
Non-Food Inflation	L	Constant	1	-1.326	I(1)
	1D		1	-3.106	

Critical Values	
Constant	**Constant and Trend**
1%: -2.611	**1% :**
5%: -2.178	**5%:**

Note: 1. L = level, 1D = 1st Difference and 2D =2nd difference I(K) means series is not stationary after second difference
2.** Stationary at 1%
3. * Stationary at 5%

Appendix Table 2: Zivot–Andrews (ZA) Unit Root Test Results

Variable	Transformation	Break Date	Test Statistics	Conclusion
Inflation Rate	L	2023m8	-2.239	I(1)
	1D	2023m12	-5.750[s]	
Broad Money Growth	L	2022m11	-4.035	I(1)
	1D	2024m1	-10.068[s]	
World Energy Price	L	2021m9	-3.036	I(1)
	1D	2022m7	-7.581[s]	
World Food Price	L	2022m1	-4.892	I(1)
	1D	2022m4	-6.968[s]	
Lending Rate	L	2024m1	-3.686	I(1)
	1D	2023m12	-6.960[s]	
Exchange Rate Depreciation	L	2022m9	-3.561	I(2)
	1D	2023m6	-5.039	
	2D	2022m11	-7.956[s]	
Food Inflation	L	2023m4	-2.695	I(1)
	1D	2023m10	-5.583[s]	
Non-Food Inflation	L	2023m8	-2.584	I(1)
	1D	2023m12	-6.337[s]	
Critical Values				
Constant and Trend				
1% : -5.57				
5%: -5.08				

Note: 1. L = level, 1D = 1st Difference and 2D =2nd difference I(K) means series is not stationary after second difference
2. ** Stationary at 1%
3. * Stationary at 5%

Appendix Table 3: Perron-Vogelsang Single Break Unit Root Test Result

Variable		Additive Outlier (Immediate Break)			Innovative Outlier (Gradual Break)			Conclusion
		Breakpoint	**P-Value for Break**	**Test Statistics**	**Breakpoint**	**P-Value for Break**	**Test**	
Inflation Rate	L	2023m3	0.000	-2.860	2021m12	0.045	-2.232	I(2)
	1D	2023m11	0.000	-1.216	2023m11	0.034	-3.435	
	2D	2023m6	0.825	-5.194[s]	2023m7	0.018	-6.572[s]	
Broad Money Growth	L	2022m10	0.429	-2.948	2022m11	0.747	-3.317	I(1)
	1D	2022m10	0.919	-1.809	2022m11	0.128	-4.942[s]	
	1D	2020m6	0.658	-2.398	2020m7	0.016	-6.542[s]	
World Energy Price	L	2021m11	0.000**	-3.130	2020m10	0.037	-2.949	I(1)
	1D	2022m1	0.336	-4.025[s]	2022m2	0.078	-7.885[s]	
world food price	L	2021m2	0.000**	-3.257	2020m7	0.032	-2.786	I(1)
	1D	2022m1	0.087	-3.038	2022m2	0.001**	-6.932[s]	
Lending Rate	L	2024m6	0.000**	-2.952	2020m11	0.597	-0.347	I(1)
	1D	2024m7	0.011	-6.362[s]	2021m2	0.338	-8.386[s]	
Exchange Rate Depreciation	L	2021m12	0.001**	-1.272	2021m1	0.026	-2.261	I(1)
	1D	2021m1	0.957	-1.751	2021m2	0.495	-25.049[s]	
Food Inflation	L	2023m3	0.000	-1.647	2021m12	0.002	-4.364[s]	I(0)
Non-Food Inflation	L	2022m8	0.000	-2.447	2021m7	0.147	-1.831	I(2)
	1D	2024m3	0.000	-2.298	2023m12	0.014	-3.113	
	2D	2023m6	0.919	-4.374	2023m7	0.041	-7.063[s]	
5% Critical Values: **Additive Outlier: -3.560** **Innovative Outlier: -4.270**								

Note: 1. L = level, 1D = 1st Difference and 2D =2nd difference.
2. I(K) means series is not stationary after second difference
3. [S] = stationary
4. ** significant at 1%

Appendix Table 4: Clemente-Montanes-Reyes (double break) Unit Root Test Results

Panel A: Additive Outlier (Immediate Break) Results

Variable		First Break			Second Break			Conclusion
		Breakpoint	P-Value for Break	Test Statistics	Breakpoint	P-Value for Break	Test	
Inflation Rate	L	2022m8	0.000**	-3.793	2024m7	0.000**	-3.793	I(1)
	1D	2021m7	0.000**	-5.705[s]	2023m11	0.000**	-5.705[s]	
Broad Money Growth	L	2020m5	0.130	-1.418	2022m10	0.927	-1.418	I(K)
	1D	2022m10	0.936	-3.315	2023m4	0.867	-3.315	
	2D	2022m10	0.846	-1.388	2023m4	0.724	-1.388	
World Energy Price	L	2021m11	0.000**	-3.326	2023m3	0.000**	-3.326	I(K)
	1D	2020m1	0.533	-4.154	2022m1	0.258	-4.154	
	2D	2020m1	0.771	-3.501	2022m1	0.789	-3.501	
world food price	L	2021m2	0.000**	-4.288	2023m7	0.000**	-4.288	I(K)
	1D	2020m11	0.444	-3.512	2022m1	0.076	-3.512	
	2D	2022m1	0.498	-3.756	2022m4	0.552	-3.756	
Lending Rate	L	2021m2	0.000**	-0.984	2022m10	0.000**	-0.984	I(K)
	1D	2021m1	0.893	-2.512	2023m12	0.044	-2.512	
	2D	2020m11	0.637	-4.314	2024m6	0.994	-4.314	
Exchange Rate Depreciation	L	2020m12	0.042	-3.473	2022m12	0.070	-3.473	I(K)
	1D	2021m1	0.999	-1.663	2022m1	0.955	-1.663	
	2D	2021m1	0.844	-0.358	2022m1	0.950	-0.358	
Food Inflation	L	2022m7	0.000	-3.421	2024m3	0.000	-3.421	I(2)
	1D	2021m11	0.008	-3.448	2023m9	0.000	-3.448	
	2D	2021m11	0.933	-5.917	2023m8	0.773	-5.917	
Non-Food Inflation	L	2020m8	0.025	-2.892	2022m7	0.000	-2.892	I(1)
	1D	2021m4	0.001	-6.820[s]	2023m12	0.000	-6.820[s]	
Additive Outlier 5% Critical Values : -5.490								

Panel B: Innovative Outlier (Gradual Break) Results

Variable		First Break			Second Break			Conclusion
		Breakpoint	P-Value for Break	Test Statistics	Breakpoint	P-Value for Break	Test	
Inflation Rate	L	2022m1	0.134	-2.140	2024m4	0.755	-2.140	I(1)
	1D	2021m8	0.000**	-6.412[s]	2023m11	0.000**	-6.412[s]	
Broad Money Growth	L	2020m6	0.407	-1.837	2022m11	0.576	-1.837	I(2)
	1D	2022m11	0.514	-3.848	2023m5	0.970	-3.848	
	2D	2022m11	0.044	-5.906[s]	2023m6	0.039	-5.906[s]	
	1D	2020m7	0.029	-4.426	2021m8	0.690	-4.426	
	2D	2020m7	0.000**	-6.758[s]	2021m4	0.000**	-6.758[s]	
World Energy Price	L	2021m7	0.002**	-3.640	2022m10	0.030	-3.640	I(1)
	1D	2020m2	0.045	-9.366[s]	2022m2	0.003**	-9.366[s]	
world food price	L	2020m9	0.001	-3.750	2023m3	0.024	-3.750	I(1)
	1D	2020m3	0.066	-7.348[s]	2022m2	0.000**	-7.348[s]	
Lending Rate	L	2020m11	0.067	-1.491	2022m11	0.020	-1.491	I(1)
	1D	2020m11	0.000**	-9.782[s]	2021m2	0.000**	-9.782[s]	
Exchange Rate Depreciation	L	2021m1	0.005*	-2.670	2023m1	0.072	-2.670	I (1)
	1D	2021m2	0.941	-27.191[s]	2022m2	0.778	-27.191[s]	
Food Inflation	L	2022m1	0.002	-4.139	2024m2	0.765	-4.139	I(1)
	1D	2021m12	0.003	-5.640	2023m8	0.000**	-5.640[s]	
Non-Food Inflation	L	2020m2	0.304	-1.812	2021m10	0.140	-1.812	I(2)
	1D	2021m4	0.003	-4.587	2023m11	0.001	-4.587	
	2D	2023m1	0.100	-8.154	2023m7	0.647	-8.154	
Innovative Outlier 5% Critical Values : -5.490								

Note:1. L = level, 1D = 1st Difference and 2D =2nd difference. 2. I(K) means series is not stationary after second differencing