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ASYMMETRIC EXCHANGE RATE PASS-THROUGH TO INFLATION IN SIERRA LEONE: EVIDENCE FROM A NONLINEAR ARDL MODEL

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Abstract:
This article examines asymmetric exchange-rate pass-through to inflation in Sierra Leone using annual data for 1980–2024 and a Nonlinear Autoregressive Distributed Lag model (NARDL). The analysis separates depreciation from appreciation in order to test whether exchange rate losses and gains transmit differently to domestic prices, while controlling for money supply, petroleum import prices and real GDP. Unit-root results show a combination of I(0) and I(1) variables, supporting the NARDL approach, and the bounds test confirms a long-run relationship among the variables. The long-run estimates indicate that money supply and petroleum import prices are the main determinants of inflation, whereas the long-run asymmetric exchange rate effects are not statistically significant. In the short run, depreciation raises inflation more strongly than appreciation reduces it, and this asymmetric response is supported by the Wald test and dynamic multiplier evidence. The findings suggest that inflation control in Sierra Leone requires exchange rate stability, prudent liquidity management, lower exposure to imported fuel and stronger domestic production capacity.

JEL: E31; F31; F41; C32; O55

Keywords: exchange rate pass-through; inflation; asymmetry; NARDL; Sierra Leone; monetary policy

1. Introduction

Exchange rate movements are a major channel through which external shocks affect domestic prices in small open economies. Exchange rate pass-through (ERPT) refers to the extent to which movements in the nominal exchange rate are transmitted to domestic prices through imported goods, production inputs, fuel costs, distribution costs and expectations (Campa & Goldberg, 2005; Aron, MacDonald, & Muellbauer, 2014). In

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import-dependent economies, depreciation of the domestic currency can quickly raise the local currency cost of imports and intensify inflationary pressure. Appreciation, however, may not reduce prices by the same magnitude because of price rigidities, market power, menu costs, and firms' tendency to preserve profit margins (Bussière, 2013; Delatte & López-Villavicencio, 2012). Where imports account for a large share of household consumption and production activity, exchange rate movements can become a direct channel through which external shocks enter the domestic price system.

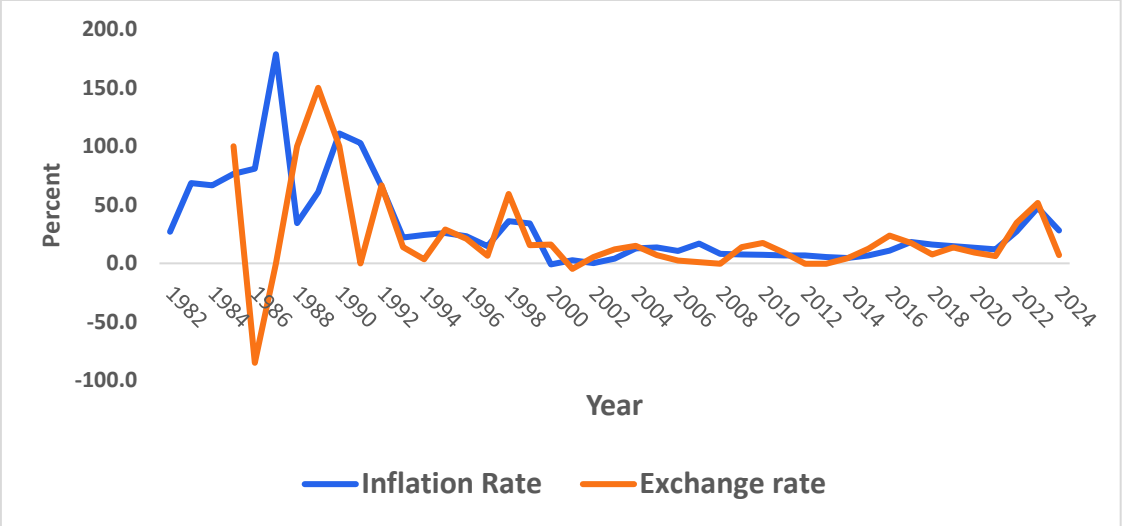
The theoretical literature presents three channels that explain exchange rate pass-through to domestic prices. The purchasing power parity and law of one price frameworks suggest that exchange rate movements are transmitted to domestic prices through changes in the local-currency cost of traded goods. Under this view, depreciation raises import prices and domestic inflation, while appreciation should reduce them. However, pricing-to-market and market-structure theories focus on asymmetric pass-through, suggesting that firms with market power may raise prices quickly when depreciation increases costs but avoid reducing prices fully when appreciation lowers costs because of menu costs, weak competition, strategic pricing and the desire to protect profit margins (Campa & Goldberg, 2005; Bussière, 2013). As a result, depreciation may have a stronger inflationary effect than appreciation has a disinflationary effect. Production-cost and import-dependence theories further suggest that exchange rate depreciation affects inflation not only through final imported goods but also through domestic production and distribution costs, an argument that is especially relevant for small open economies that rely on imported petroleum products, food items, intermediate inputs and transport-related goods (Aron, MacDonald, & Muellbauer, 2014).

Sierra Leone provides an important case for examining asymmetric exchange rate pass-through because the economy is highly import-dependent and has experienced prolonged episodes of exchange rate depreciation, inflationary pressure and exposure to global commodity price shocks (Bangura, Caulker, & Pessima, 2012). The economy depends heavily on imported petroleum products, food items, machinery, manufactured goods and other essential inputs. Depreciation of the Leone increases import costs and can quickly influence pump prices, transport fares, food distribution, production expenses and retail prices. These pressures are often reinforced by supply-side bottlenecks, limited domestic substitutes and expectations of further depreciation. As a result, exchange rate movements can contribute to inflation even when the original shock occurs outside the domestic economy. However, the pass-through process may not be symmetric. When the exchange rate depreciates, firms and traders may adjust prices upward quickly to protect margins and cover replacement costs. When the exchange rate appreciates, prices may fall slowly or remain unchanged because of menu costs, weak competition, inventory costs, uncertainty and the desire to recover earlier losses (Delatte & López-Villavicencio, 2012; Bussière, 2013).

The trends in inflation and the exchange rate indicate a strong relationship between price instability and movements in the value of the national currency, as shown

in Figure 1. Both indicators were highly volatile in the 1980s and early 1990s, a period marked by weak macroeconomic conditions, foreign-exchange shortages, and political uncertainty. In the 1990s, the civil conflict disrupted production, trade, and investor confidence, placing upward pressure on prices and contributing to exchange-rate depreciation. These disruptions reduced domestic supply while increasing uncertainty in the foreign exchange market. As the domestic currency weakened, the local-currency cost of imported goods increased, transmitting exchange-rate pressure to consumer prices. Inflationary pressure was also driven by fiscal deficits, monetary expansion, weak production capacity, and limited export earnings. External factors intensified these pressures, particularly increases in the prices of imported fuel, food, fertilizer, machinery, medicine, and transport services. Since Sierra Leone is an import-dependent economy, higher global prices and currency depreciation were quickly passed on to households through higher retail prices.

Figure 1: Inflation and Exchange Rate



During the post-war period, particularly from the 2000s to the mid-2010s, inflation and exchange-rate pressures became relatively more stable, suggesting improvements in policy coordination, monetary management, fiscal discipline, donor support and foreign-exchange availability. This period of relative stability implies that stronger macroeconomic management helped reduce the frequency and severity of price shocks. However, the Ebola outbreak in 2014–2016 disrupted labour markets, agriculture, mining, trade and cross-border movement, weakened output and created renewed pressure on prices and the exchange rate. In the early 2020s, inflation and exchange rate pressures intensified. The COVID-19 pandemic, global supply-chain disruptions, higher fuel and food prices, rising freight costs, the Russia–Ukraine war, foreign-exchange shortages and domestic fiscal pressures contributed to higher import costs. These shocks affected both the supply side, through higher production and transport costs, and the demand side, through pressure on public finances and foreign-currency demand.

Currency depreciation amplified these shocks by making essential imports more expensive in domestic-currency terms, leading to a surge in domestic prices.

Overall, the analysis shows that exchange-rate depreciation is a key channel through which domestic weaknesses and external shocks affect inflation. By raising import and business costs, depreciation reduces household purchasing power and contributes to price increases. The evidence also suggests that inflation becomes more persistent when depreciation, supply shortages, and fiscal pressures occur at the same time. Sustained inflation control therefore requires credible fiscal management, prudent monetary policy, stronger foreign-reserve management, expanded domestic food and energy production, export diversification, and reduced dependence on imported inputs and consumer goods.

The central problem addressed in this article is that policy discussions often treat the inflationary effect of depreciation and the disinflationary effect of appreciation as broadly symmetric. If that assumption is wrong, policymakers may underestimate the inflationary risk created by depreciation and overstate the extent to which appreciation can reverse earlier price increases. This distinction is especially important for Sierra Leone, where exchange-rate pressure interacts with imported fuel costs, liquidity conditions and supply-side constraints.

Against this background, the study examines the asymmetric exchange-rate pass-through to inflation in Sierra Leone using annual data from 1980 to 2024 and the Nonlinear Autoregressive Distributed Lag framework developed for asymmetric cointegration analysis (Shin, Yu, & Greenwood-Nimmo, 2014). The article contributes updated country-specific evidence by separating depreciation from appreciation and testing short-run and long-run asymmetry while controlling for money supply, petroleum import prices and real output.

The remainder of the article is organized as follows. Section 2 reviews the empirical literature on exchange-rate asymmetry and inflation dynamics. Section 3 outlines the methodology, including the model specification, variable decomposition and estimation strategy. Section 4 presents and discusses the empirical findings. Section 5 concludes the study and sets out the main policy implications.

2. Literature Review

2.1 African Evidence

Evidence from African economies generally points to incomplete but often asymmetric exchange-rate pass-through, especially in countries that rely heavily on imported fuel, food and production inputs. In Nigeria, Ikue et al. (2024) applied ARDL and NARDL models to quarterly data for 2010Q1–2024Q2 and reported that depreciation creates faster and stronger inflationary pressure than appreciation, particularly for food prices. Sa'ad, Usman, Omaye and Yau (2023) also identified asymmetric inflation effects from oil-price shocks and depreciation. Ghanaian evidence points in a similar direction. Obeng et al. (2022), using an empirical-mode-decomposition NARDL model with monthly data for

1990–2020, reported short- and long-run asymmetry with larger effects during depreciation. Amoah and Aziakpono (2018) used Johansen cointegration and vector error-correction methods to estimate symmetric and asymmetric exchange-rate pass-through to consumer prices in Ghana, focusing on the nominal effective exchange rate and asymmetry by both direction and size of exchange-rate movements. They found incomplete pass-through and larger depreciation effects. For Sierra Leone, Danlami, Hidthiir and Hassan (2019) applied ARDL and NARDL models to annual data for 1970–2016 and found that exchange-rate movements affected inflation mainly in the short run under the symmetric model, while the nonlinear model showed short-run inflationary effects from positive exchange-rate shocks and long-run disinflationary effects from negative shocks. Earlier evidence from Bangura, Caulker and Pessima (2012), based on annual data for 1980–2011 and a SVAR model, showed significant but incomplete pass-through, with nominal depreciation acting as an important source of inflationary pressure. Lavhelalani (2024), using quarterly South African data from January 2015 to July 2023, found nonlinear pass-through but no significant long-run asymmetry.

2.2 Asian Evidence

Studies from Asian economies also confirm that pass-through differs across countries and price indices. Nguyet (2026) analysed Vietnam using a nonlinear ARDL model with monthly data from 2005 to 2023 and found that depreciation produces a larger inflationary impulse than appreciation produces a disinflationary offset, while oil prices were identified as the dominant long-run driver of inflation. In India, Parab (2022) estimated linear and nonlinear ARDL models using quarterly data from 2005Q2 to 2021Q2 and found less-than-complete pass-through, with stronger effects on wholesale prices than consumer prices because of India's exposure to crude-oil imports. Unlike many African studies, Parab reported stronger pass-through from appreciation than depreciation, highlighting the importance of country-specific policy responses and market structures.

2.3 Other Emerging Economies

Evidence from other emerging and small open economies further supports the relevance of nonlinear modelling. Tanku and Skufi (2026) examined Albania using a Q-NARDL model with monthly data for 2002–2024 and found that depreciation has a stronger inflationary effect than appreciation, especially at higher inflation quantiles. Obradović (2025) used a NARDL framework for Serbia with quarterly data from 2012Q1 to 2021Q4 and found that depreciation had a stronger and statistically significant inflationary effect than appreciation. In Brazil, Salomão Neto and Alves (2025) applied NARDL models over 1999–2024 and found that the size and direction of asymmetry vary across inflation categories, with stronger depreciation effects for broad consumer, free and non-tradable prices. In Morocco, El Haddadi and Lahjouji (2026) examined exchange rate pass-through effects on food and cereal inflation using an ARDL framework and additional nonlinear NARDL estimations to test for asymmetry under climate-change constraints. Their study

relied on monthly data and controlled for major structural shocks, using food-price inflation indicators alongside the nominal effective exchange rate, world oil prices, international cereal prices, import volumes and rainfall as macroeconomic, external and climatic variables. The results showed strong inflation inertia and a stable long-run relationship in food and cereal inflation, but no evidence of asymmetric exchange rate pass-through, suggesting that subsidies, managed exchange rate arrangements and domestic supply-chain conditions can weaken the exchange-rate channel.

2.4 Advanced and Cross-country Evidence

Multi-country studies provide broader support for the view that ERPT depends on inflation history, trade structure, policy credibility and market conditions. Syamad and Handoyo (2023) compared inflation-targeting economies using Autoregressive Distributed Lag (ARDL) and Nonlinear Autoregressive Distributed Lag (NARDL) models. Their study used quarterly time-series data covering 2000Q1–2021Q4 for middle-income inflation-targeting countries, namely South Africa, Brazil, India, Indonesia and Mexico, and high-income inflation-targeting countries, namely Australia, Japan, Canada, Norway and Sweden. The analysis focused on inflation and the real exchange rate, while also including oil prices, money supply and real GDP as additional macroeconomic controls. They found stronger average exchange rate pass-through in middle-income countries than in high-income countries, implying that inflation-targeting frameworks tend to operate more flexibly in high-income economies. Bussière (2013), using G7 trade-price data, found significant nonlinearities and asymmetries, while Delatte and López-Villavicencio (2012) found that prices in major developed economies respond more strongly to depreciation than appreciation. Earlier evidence from Campa and Goldberg (2005), Choudhri and Hakura (2006), and Goldfajn and Werlang (2000) also shows that pass-through is partial, varies across inflation environments and tends to be stronger where inflation is high, markets are less competitive or exchange rate misalignment is large.

2.5 Research Gap and Contribution of This Article

Although many studies show that exchange-rate pass-through to inflation is incomplete, nonlinear and asymmetric, the evidence remains country-specific and mixed. For Sierra Leone, the available evidence is limited and relatively dated. Bangura, Caulker and Pessima (2012) used a SVAR approach, while Danlami, Hidthiir and Hassan (2019) applied ARDL and NARDL methods using data only up to 2016. These earlier studies do not capture more recent inflationary episodes linked to the Ebola aftermath, COVID-19 disruptions, global fuel and food price increases, sharp exchange-rate depreciation and renewed macroeconomic pressures. This article contributes updated Sierra Leone-specific evidence using annual data from 1980 to 2024 and applying the NARDL framework to separate depreciation from appreciation effects. It also improves on earlier work by controlling for money supply, petroleum import prices and real GDP, thereby distinguishing exchange-rate effects from monetary, imported-cost and real-sector

drivers of inflation. The main contribution is therefore both methodological and policy-oriented: the study assesses whether depreciation has a stronger inflationary effect than appreciation has a disinflationary effect in Sierra Leone's small, import-dependent economy.

3. Methodology

This section presents the empirical strategy used to examine asymmetric exchange rate pass-through to inflation in Sierra Leone. It describes the model specification, variable decomposition, estimation procedure and cointegration framework. The methodological approach is designed to capture both the long-run relationship among the variables and the short-run differences between the inflationary effect of depreciation and the disinflationary effect of appreciation.

3.1 Model Specification

The empirical model specifies inflation in Sierra Leone as a function of exchange rate movements, monetary conditions, imported petroleum-price pressures and real economic activity. This specification follows the exchange rate pass-through literature, which links domestic inflation to exchange rate changes, money supply, external price shocks and output conditions (Goldfajn & Werlang, 2000; Choudhri & Hakura, 2006; Aron, MacDonald, & Muellbauer, 2014).

In its general long-run form, inflation is expressed as:

$$P_t = f\left(EX_t, Y_{t,} MS_t, OP_{t_{,,}}\right) \quad (1)$$

where P denotes the inflation rate, EX is the nominal exchange rate, MS represents broad money supply, OP captures the import price of petroleum products, and Y represents real output.

In empirical form, the long-run relationship can be written as:

$$P_t = \alpha_0 + \beta_1 EX_t + \beta_2 Y_t + \beta_3 MS_t + \beta_4 OP_e + \varepsilon_t \quad (2)$$

To identify asymmetry in exchange rate pass-through, the exchange rate series is decomposed into positive and negative partial-sum components. The positive component, EX^+, captures cumulative exchange rate depreciation, while the negative component, EX^-, captures cumulative exchange rate appreciation. This decomposition allows depreciation and appreciation to affect inflation separately, rather than imposing a single symmetric exchange rate response.

The asymmetric long-run form is therefore specified as follows:

$$P_t = \alpha_0 + \lambda_1 EX_t^+ + \lambda_2 EX_t^- + \beta_2 Y_t + \beta_3 MS_t + \beta_4 OP_e + \varepsilon_t \quad (3)$$

In this formulation, the depreciation coefficient λ_1, measures the inflationary effect of a weakening domestic currency, while the appreciation coefficient λ_2, measures the price response to a strengthening currency. Long-run asymmetry is established where the two exchange rate coefficients differ statistically.

3.2 Estimation Strategy

Equation (3) is estimated within a nonlinear Autoregressive Distributed Lag framework. This approach extends the ARDL model by permitting depreciation and appreciation to enter the inflation equation separately, making it possible to estimate distinct short-run and long-run responses to positive and negative exchange-rate movements (Pesaran, Shin, & Smith, 2001; Shin, Yu, & Greenwood-Nimmo, 2014). It is also appropriate for the present sample because the method can be used when regressors are a mixture of I(0) and I(1), as long as no variable is integrated of order two.

The NARDL model is specified as:

$$\Delta P_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta P_{t-i} + \sum_{j=0}^{q} \beta_j^{+} \Delta EX_{t-j}^{+} + \sum_{j=0}^{q} \beta_j^{-} \Delta EX_{t-j}^{-} + \sum_{k=0}^{s} \gamma_1 \Delta Y_{t-k} + \sum_{i=0}^{m} \gamma_2 \Delta MS_{t-i} + \sum_{i=0}^{m} \gamma_3 \Delta OP_{t-i} + \lambda_1 P_{t-1} + \lambda_2^{+} EX_{t-1}^{+} + \lambda_3^{-} EX_{t-1}^{-} + \lambda_4 Y_{t-1} + \lambda_5 MS_{t-1} + \lambda_6 OP_{t-1} + \varepsilon_t \quad (4)$$

In Equation (4), the first-difference terms capture the short-run dynamics of the variables, while the lagged level terms represent the long-run relationship. The positive and negative exchange rate changes allow the model to test whether depreciation and appreciation transmit differently to domestic inflation. The short-run coefficients measure immediate responses, while the long-run coefficients capture the persistent effects of each explanatory variable on inflation.

The estimation proceeds in three stages. First, unit-root tests are conducted to determine the order of integration of each variable. Second, the bounds-testing procedure is applied to examine whether a stable long-run relationship exists among inflation, exchange-rate movements, money supply, petroleum import prices and real output. Third, where cointegration is confirmed, the NARDL model is estimated in error-correction form to assess both short-run asymmetry and adjustment toward long-run equilibrium. To test for cointegration, the bounds test is specified as follows:

$$H_0: \lambda_1 = \lambda_2 = \cdots .. = \lambda_6 = 0 \ (No\ cointegration)$$

$$H_1: \lambda_1 \neq \lambda_2 \neq \cdots . \neq \lambda_6 \neq 0 \ (cointegration)$$

The computed F-statistic is compared with the lower and upper critical bounds proposed by Pesaran, Shin and Smith (2001). If the F-statistic exceeds the upper bound, the null hypothesis of no cointegration is rejected, indicating a long-run relationship. If it falls below the lower bound, the null hypothesis cannot be rejected. An inconclusive result occurs when the statistic lies between the two bounds. Once cointegration is established, Equation (4) is re-specified into error-correction form as follows:

$$\Delta P_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta P_{t-i} + \sum_{j=0}^{q} \beta_j^{+} \Delta EX_{t-j}^{+} + \sum_{j=0}^{q} \beta_j^{-} \Delta EX_{t-j}^{-} + \sum_{k=0}^{s} \gamma_1 \Delta Y_{t-k} + \sum_{i=0}^{m} \gamma_2 \Delta MS_{t-i} + \sum_{i=0}^{m} \gamma_3 \Delta OP_{t-i} + \theta ECM_{t-1} + \varepsilon_t \quad (5)$$

where the error-correction term θ, measures the speed at which inflation returns to its long-run equilibrium after a short-run shock. A negative and statistically significant coefficient confirms convergence and indicates that deviations from equilibrium are corrected over time.

4. Results and Discussion

This section reports on the key empirical findings. The discussion focuses on descriptive patterns, stationarity, lag selection, cointegration, long-run and short-run NARDL estimates, asymmetry, and diagnostic tests.

4.1 Unit-Root Test Results

The ADF and PP test results in Table 1 show mixed integration orders. The exchange rate and money supply are stationary at level, while inflation, petroleum import prices and real GDP become stationary after first differencing. This mixture of I(0) and I(1) variables supports the use of the ARDL/NARDL approach, provided no variable is integrated of order two (Pesaran, Shin, & Smith, 2001; Shin, Yu, & Greenwood-Nimmo, 2014).

Table 1: Results of Unit Root Test

Variables	Augmented Dickey Fuller (ADF) Test			Phillips-Perron Test		
	Level	1st Difference	Order of Integration	Level	1st Difference	Order of Integration
P	-0.068	-4.113**	I(1)	-0.068	-10.137***	I(1)
EX	-2.892*	-3.433**	I(0)	-2.893	-15.965***	I(0)
MS	-2.029*	-10.79***	I(0)	-2.029	-13.486***	I(0)
OP	-1.830	-3.394**	I(1)	-1.830	-11.432***	I(1)
Y	-1.278	-4.260**	I(1)	-1.277	-10.127***	I(1)

Source: Eviews 14 output.

4.2 Optimal Lag Selection

Table 2 reports the optimal lag-length results. The information criteria indicate a maximum lag of one, which is adopted to capture short-run dynamics without over-parameterising the model.

Table 2: Optimal Lag Result

Lag	LogL	LR	FPE	AIC	SC	HQ
0	515.60	NA	3.89e-15	-13.32	-11.50*	-12.60
1	599.95	132.02*	1.46e-15*	-14.34*	-10.94	-12.99*
2	638.72	52.82	2.19e-15	-14.05	-9.063	-12.07
3	689.26	58.59	2.63e-15	-14.09	-7.52	-11.48

Source: Eviews 14 output.

4.3 Cointegration Bounds Test

The bounds test in Table 3 confirms cointegration. The F-statistics of 7.839 exceeds the upper critical bounds at conventional significance levels, indicating a stable long-run relationship among inflation, exchange-rate movements, money supply, petroleum import prices and real GDP, consistent with the ARDL bounds-testing procedure of Pesaran, Shin and Smith (2001).

Table 3: ARDL F-bounds Test Result for Cointegration

Null hypothesis: No long-run relationship exists		
Test Statistic	**Value**	**K**
F-statistic	7.839	5
Critical Value Bounds		
Significance	**Lower Bound**	**Upper Bound**
10%	2.17	3.19
5%	2.72	3.83
2.50%	3.22	4.5
1%	3.88	5.3

Source: Eviews 14 output.

4.4 Long-Run NARDL Estimates

Table 4 presents the long-run NARDL estimates. The results indicate that money supply and petroleum import prices are the main long-run determinants of inflation in Sierra Leone. The positive and statistically significant money-supply coefficient suggests that higher domestic liquidity places upward pressure on prices over time. Thus, a one-percentage-point increase in money supply is associated with an estimated 0.24 percentage-point increase in inflation. This finding is consistent with the monetary view of inflation and with evidence that liquidity conditions and the inflationary environment influence exchange-rate pass-through and price dynamics (Choudhri & Hakura, 2006; Ganawah, 2021). It also aligns with the findings of Daboh, Duramany-Lakkoh and Knox-Goba (2024) and Mandler and Scharnagl (2025).

The positive and significant coefficient of petroleum import prices also confirms the importance of imported cost-push inflation. Thus, a one-percentage-point increase in the import price of petroleum is associated with an estimated 0.33 percentage-point increase in inflation. Sierra Leone is a net importer of petroleum products, and fuel prices feed into domestic inflation through transport fares, food-distribution costs, electricity generation, production expenses and retail margins. A rise in petroleum import prices therefore affects the general price level directly through fuel consumption as well as indirectly through the cost structure of goods and services. This finding is consistent with the studies by Banerjee et al. (2026) and Kouadio (2024).

Table 4: Long-run Results of the NARDL Model (Asymmetric Estimates of Inflation)

Variables	Coefficient	Std. Error	t-Statistics	Prob
EX^+	0.0674	0.0578	1.1660	0.2528
EX^-	-0.0111	0.0067	-1.6599	0.1073
MS	0.2402	0.1113	2.1573	0.0391
OP	0.3335	0.1507	2.2129	0.0393
Y	0.0371	0.0198	1.8736	0.1708

Source: Eviews 14 output.

By contrast, the long-run coefficients of the positive and negative exchange rate components are not statistically significant. The depreciation component is positive, as expected, while the appreciation component is negative, but neither effect is strong enough to establish long-run exchange rate asymmetry. This suggests that exchange rate movements matter more immediately than permanently once money supply, petroleum import prices and output are controlled for. In Sierra Leone, this may reflect the fact that depreciation initially raises import costs, but over the long run inflation is sustained more by liquidity conditions, fuel-price adjustments, supply constraints and expectations than by the exchange rate alone. The finding is consistent with Sierra Leone-specific evidence. Kargbo (2014) found that petroleum product prices, exchange rate movements and monetary factors determine domestic prices in Sierra Leone, but that petroleum-price effects were mainly short-run rather than persistent in the long run.

4.5 Short-Run NARDL Estimates and Asymmetry Test

The short-run NARDL estimates in Table 5 indicate a strong and statistically significant adjustment mechanism. The error-correction coefficient is negative and significant at -0.661, with a probability value of 0.00. This confirms convergence toward the long-run inflation equilibrium and implies that about 66.1% of short-run disequilibrium is corrected within one period. The relatively high speed of adjustment suggests that inflation in Sierra Leone responds quickly to macroeconomic shocks, particularly those transmitted through exchange rate movements, imported fuel costs and liquidity conditions. The model also performs well statistically, with an R-squared of 0.8084, an adjusted R-squared of 0.7859 and a Durbin-Watson statistic of 2.0535.

Table 5: Short-run Results of the NARDL Model (Asymmetric Estimates of Inflation)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(P(-1))	-0.30609	0.11774	-2.59966	0.0352
$D(EX^+)$	0.42120	0.16720	2.51870	0.0384
$D(EX^+(-1))$	0.48342	0.17033	2.83807	0.0335
$D(EX^-)$	-0.29231	0.07979	-3.66401	0.0212
$D(EX^-(-1))$	-0.19403	0.05937	-3.26815	0.0281
D(MS)	-0.10426	0.23378	-0.44597	0.6662
D(MS (-1))	0.21320	0.08679	2.45637	0.0391
D(OP)	0.31195	0.07355	4.24110	0.0002
D(OP(-1))	0.00137	0.28885	0.00474	0.9963
D(Y)	-0.38129	0.35524	-1.07335	0.3026

CointEq(-1)*	-0.66149	0.08378	-7.89579	0.0000
R-squared	0.808419			
Adjusted R-squared	0.785880			
Durbin-Watson stat	2.05349			
Wald test for asymmetric effect	F(1, 31)= 26.653 (0000)			

Source: Author's estimation.

The exchange rate coefficients provide clear evidence of short-run asymmetric pass-through. The current-period depreciation component, $D(EX^{+})$, is positive and statistically significant, with a coefficient of 0.42 and a probability value of 0.03. The one-period lag of depreciation, $D(EX^{+}(-1))$, is also positive and significant, with a larger coefficient of 0.48 and a probability value of 0.03. These results show that depreciation of the Leone raises inflation immediately and continues to exert inflationary pressure in the following period.

The appreciation coefficients are negative, as expected, but their magnitudes are smaller than the combined depreciation effects. The current-period appreciation component, $D(EX^{-})$, has a coefficient of -0.29 and is statistically significant at the 5% level, while $D(EX^{-}(-1))$ has a coefficient of -0.19 and is also significant. This indicates that exchange rate appreciation reduces inflation in the short run, but the reduction is weaker than the inflationary effect of depreciation. The Wald test further confirms this asymmetric response, with $F(1,31) = 26.65$ and a probability value of 0.0000. The rejection of symmetry means that inflation responds differently to exchange rate losses and gains, with depreciation transmitting more strongly to prices than appreciation.

These findings are consistent with recent evidence from comparable import-dependent African economies. Ikue et al. (2024) found for Nigeria that exchange rate depreciation exerts stronger and more immediate inflationary pressure than appreciation, particularly for food inflation, with pass-through occurring within three to four quarters. Obeng et al. (2022), using an EMD-NARDL approach for Ghana, found asymmetric exchange rate pass-through in both the short run and long run, with short-run pass-through during depreciation estimated at about 81% compared with 74% during appreciation. Amoah and Aziakpono (2018) also reported asymmetric ERPT in Ghana, showing that depreciation pass-through was substantially higher than appreciation pass-through. The Sierra Leone results therefore align with the broader evidence that in small open economies, depreciation shocks tend to transmit to domestic prices more forcefully than appreciation shocks.

This pattern is consistent with the structure of the Sierra Leonean economy and with earlier evidence that exchange rate movements and monetary instability are important sources of inflationary pressure in Sierra Leone (Bangura, Caulker, & Pessima, 2012; Kargbo, 2014). Because the country depends heavily on imported fuel, food, manufactured goods and production inputs, depreciation quickly raises replacement costs for importers and traders. These higher costs are transmitted through fuel prices, transport fares, food distribution, electricity generation and retail margins. In contrast, appreciation may not translate into equivalent price reductions because traders may hold

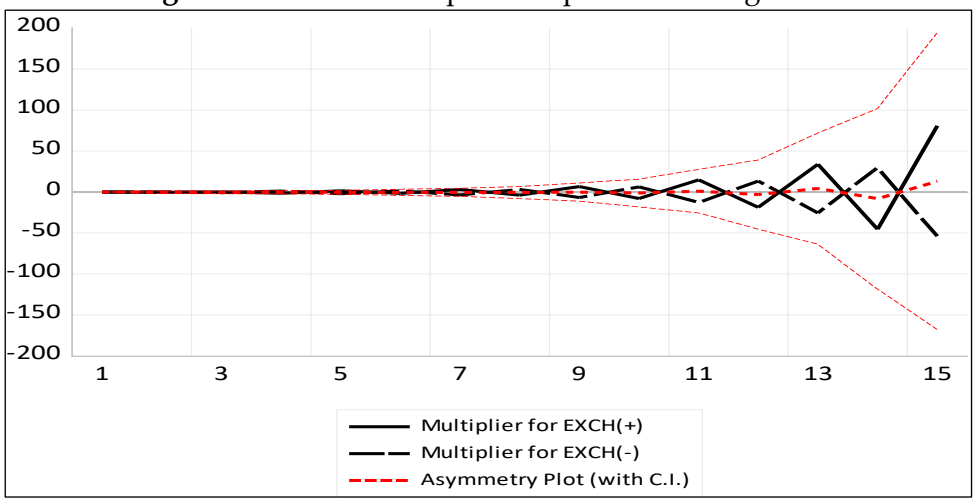
inventories purchased at higher exchange rates, face menu costs, operate in weakly competitive markets or maintain prices to recover earlier losses, producing downward price rigidity (Delatte & López-Villavicencio, 2012; Bussière, 2013).

The short-run results also show that domestic liquidity and imported petroleum costs remain important. Although the contemporaneous money-supply term is statistically insignificant, its first lag is positive and significant, with a coefficient of 0.21. This indicates that monetary expansion affects inflation with some delays rather than immediately. Petroleum import prices have an immediate and highly significant effect, with D(OP) recording a coefficient of 0.31 and a probability value of 0.0002. This confirms the strong role of fuel-related cost-push pressures in Sierra Leone's short-run inflation process, especially because fuel prices influence transport, food marketing and production costs across the economy.

4.6 The NARDL Multiplier Graph for the Exchange Rate

The NARDL multiplier graph for the impact of exchange rates on inflation, shown in Figure 2, demonstrates the asymmetric effect of exchange rate changes on inflation. The graph illustrates how positive and negative changes in the exchange rate affect inflation differently over time, indicating the adjustment of price levels toward long-run equilibrium after currency movements. In Sierra Leone, depreciation of the Leone produces a more immediate and pronounced effect on inflation, while appreciation has a weaker or delayed effect. This interpretation helps policymakers understand the inflationary implications of exchange-rate movements and manage inflation expectations.

Figure 2: NARDL Multiplier Graph for Exchange Rate



Overall, the short-run evidence supports the conclusion that exchange rate pass-through in Sierra Leone is asymmetric and policy-relevant. Depreciation has a rapid and statistically significant inflationary effect, while appreciation produces a weaker disinflationary response. This implies that relying on exchange rate appreciation alone to reverse inflationary pressures may be ineffective. Instead, policy makers need to reduce

excessive exchange rate volatility, contain liquidity growth, manage fuel-related cost shocks and strengthen domestic supply conditions so that short-run depreciation shocks do not become persistent inflationary momentum.

4.7 Summary of Key Findings

The empirical results lead to four main conclusions. First, the mixed stationarity results justify the use of the ARDL/NARDL estimation strategy. Second, the bounds test confirms a stable long-run relationship among inflation, exchange-rate movements, money supply, petroleum import prices and real output. Third, money supply and petroleum import prices are the most consistent long-run drivers of inflation, showing that domestic liquidity and imported cost pressures both matter for price stability. Fourth, exchange-rate pass-through is asymmetric in the short run: depreciation raises inflation more strongly than appreciation reduces it, indicating that exchange-rate losses are transmitted to consumer prices more forcefully than exchange-rate gains.

4.8 Diagnostic Tests

Diagnostic tests support the reliability of the estimated model. The Breusch-Godfrey LM test indicates no significant serial correlation, the Breusch-Pagan-Godfrey test suggests homoscedastic residuals, and the Jarque-Bera statistic indicates approximate residual normality. These results suggest that the estimated relationships are not driven by major econometric misspecification.

Table 6: Post Estimation Test

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	2.020556	Prob. F(2,23)	0.1554
Obs*R-squared	4.931628	Prob. Chi-Square(2)	0.0849
Heteroskedasticity Test: Breusch-Pagan-Godfrey:			
F-statistic	1.552135	Prob. F(8,24)	0.1919
Obs*R-squared	11.25196	Prob. Chi-Square(8)	0.1878
Scaled explained SS	11.2647	Prob. Chi-Square(8)	0.1871
Normality Test			
Jarque-Bera	5.339		
Prob	0.06		

Furthermore, the CUSUM and CUSUMSQ plots in Figures 3 and 4, respectively, remain within the critical bounds, suggesting that the model is stable and that the parameters do not change significantly over time.

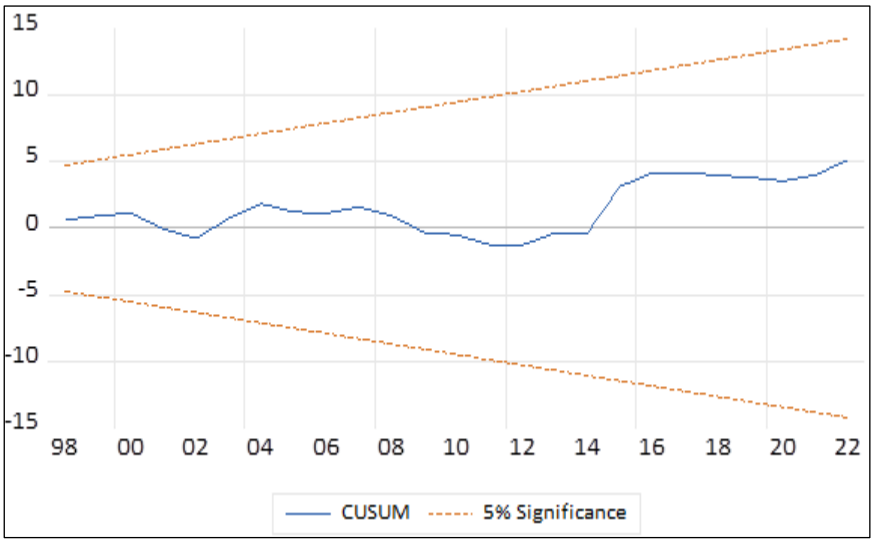


Figure 3: CUSUM Test for Stability

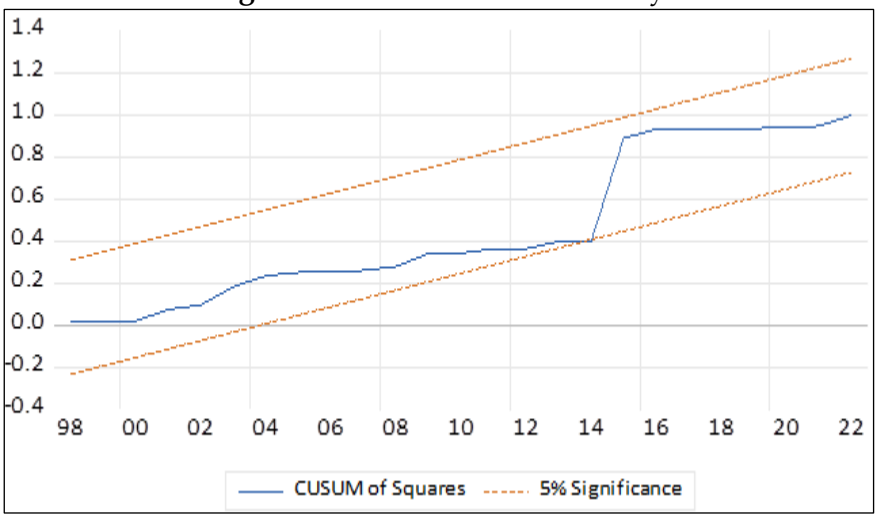


Figure 4: CUSUM Sum of Squares Test for Stability

5. Conclusion and Policy Implications

This article examined asymmetric exchange-rate pass-through to inflation in Sierra Leone using annual data for 1980–2024 within a Nonlinear ARDL framework. The ADF and PP tests showed a mixed order of integration: the exchange rate and money supply are stationary at level, while inflation, petroleum import prices and real GDP become stationary after first differencing. The bounds test confirmed cointegration, indicating a stable long-run relationship. This means that inflation in Sierra Leone is not only a response to temporary shocks but is also connected to a persistent macroeconomic structure.

The long-run estimates showed that money supply and petroleum import prices are the most robust determinants of inflation, whereas the long-run coefficients of exchange-rate depreciation and appreciation are not statistically significant. In contrast, the short-run estimates revealed a clear asymmetric pass-through, that is, depreciation of

the Leone raises inflation more strongly than appreciation reduces it, and the Wald test confirms that the response of prices to exchange-rate losses and gains is statistically different.

The significant and negative error-correction coefficient further supported the cointegration result and indicated a relatively rapid adjustment toward long-run equilibrium, with about 66.1% of short-run disequilibrium corrected within one period. This adjustment speed suggested that, inflationary disturbances arising from depreciation, liquidity expansion or petroleum-price shocks can feed quickly into the domestic price system. Overall, the findings support the conclusion that inflation in Sierra Leone reflects both long-run monetary and imported-cost fundamentals and short-run asymmetric exchange-rate effects.

5.1 Policy Implications

The policy implication is that inflation control should not rely on exchange rate management alone. In particular, the significant long-run role of money supply underscores the need for prudent liquidity management, improved monetary forecasting and stronger fiscal-monetary coordination to limit deficit-related monetary expansion and reduce pressure on the exchange rate.

The findings also highlight the importance of imported petroleum prices in the long-run inflation process. Policies that reduce exposure to fuel-price shocks, including improved fuel-storage capacity, energy diversification, transport efficiency and support for domestic production, would help weaken the imported-cost channel of inflation.

Furthermore, because depreciation produces a stronger short-run inflationary effect than appreciation produces a disinflationary effect, exchange-rate policy should aim to reduce excessive volatility, strengthen reserve buffers, improve foreign-exchange market transparency and support export diversification.

Finally, the speed of error correction suggests that policy responses must be timely and credible. Delayed action after exchange rate depreciation, fuel-price increases or excessive liquidity growth may allow short-run shocks to become embedded in inflation expectations. Thus, price stability in Sierra Leone requires an integrated policy framework that combines monetary discipline, exchange rate stability, reduced petroleum-import vulnerability, stronger domestic supply capacity and mechanisms that improve the pass-through of cost reductions to consumers.

Conflict of Interest Statement
The authors declare no conflicts of interest.

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