# DETERMINANTS OF INFLATION IN SIERRA LEONE

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**Abstract**

*This paper examines the determinants of inflation in Sierra Leone using monthly time series data from 2010M1 to 2021M12, with the application of the ARDL model. The emphasis of the empirical study as outlined in the objectives is to examine both supply-side and demand-side pressure as observed in the outcome of the short and long-run relationships. Taking into account the characteristics of the Sierra Leonean economy, which is also backed by recent studies on inflation dynamics, the constructed ARDL model emphasizes the effects of the exchange rate, RGDP, Fiscal Balance (FBAL), Currency in Circulation, and Lending Rate (LR) factors on inflation dynamics in the economy. The empirical results show that in the long-run, the main determinants of inflation in Sierra Leone are the exchange rate, Real Gross Domestic Product (RGDP), Fiscal Balance, Currency in Circulation, and Lending Rate. In the short run, all the variables except RGDP and Exchange Rate manifested significant effects on inflation dynamics. Finally, the error correction term (-0.063) was proven to be negative and statistically significant, thereby suggesting the rapid rate of adjustment to its long-run state.*

**Keywords**: *Inflation Targeting, Supply-Side, Demand-Side, Shocks, Sierra Leone*

**Jel Classification**: *C22, E20, E31*

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## 1. Introduction

According to research conducted by Jackson, Tamuke and Jabbie (2019), Korsu (2014) and Kallon (1994), inflation is a topical concern in the global economy; high inflation is considered a deterrent to economic growth, while also limiting a country's hope of attracting foreign investments. Central banks around the world are continuously setting measures in place to bring inflation under control as stated in their mandates. The process of stabilizing prices is very key in maintaining the value of a country's currency against international currencies, which also depends on a plethora of factors. Most common among the factors that contribute to inflationary pressure in an economy is the exchange rate, which as seen in developing economies like Sierra Leone is very critical in securing citizens' decent living conditions.

In the advent of the COVID-19 pandemic, inflationary pressure has become more of a worry to both developed and developing economies, which is highly attributed to supply-chain disruptions (Santacreu and LaBelle, 2022; Bobeica & Hartwig, 2022). Coupled with the continued worries of COVID-19 crises that surround inflationary pressures in the world economy, developing economies around the world, particularly Sierra Leone is likely to witness continued price pressures on account of their high dependence on import to sustain domestic consumption (Bangura, Caulker, and Pessima, 2012).

Fragility in the domestic economy, which so far can be attributed to weaknesses in real sector operations, low receipts from export of essential commodities, and fiscal tightness are some of the concerns peculiar to the country's macroeconomic stability (Korsu, 2014; Kallon 1994).

Several studies have been pursued about the root cause(s) and dominance of inflation crises in the Sierra Leone economy, which according to theory is assumed to be more monetary and fiscal issues (Frisch, 1990: 90-91; Friedman, 1972). Notable among these include an empirical investigation by Jackson et al (2020) that tested the hypothesis regarding the "*Adoption of inflation targeting in Sierra Leone*". This was done with the view of assessing whether Sierra Leone is fully ready to implement the "***full inflation targeting or inflation lite***" approach. The outcome unearthed from the empirical investigation is also in conformity with a plethora of empirical outcomes (Jackson, Tamuke and Jabbie, 2019a; Bangura et al, 2013; Kallon's 1994), which shows that inflationary pressures in Sierra Leone are not so much a monetary issue, but largely driven by the country's heavy reliance on imports to support domestic consumption and also a continuum of low receipts from export.

Given the mandate of the Bank of Sierra Leone (BSL ACT, 2019) to maintain price (categorised as low and stable inflation) and financial stability, countless efforts have been pursued to monitor inflationary movements in the country amidst prevailing pressures, which seem to be heavily dominated by supply and demand-side challenges. Such approaches have been supported by empirical efforts that incorporate the use of univariate models (ARIMA / ARIMAX)[3], typically used as a standard model by many central banks in developed economies to monitor short-term inflation dynamics, and also structural models (e.g., VAR, ARDL, etc.) that monitors dynamic interaction of macroeconomic indicators (Jackson and Tamuke, 2018; Tamuke, Jackson and Sillah, 2018; Jackson, Tamuke and Jabbie, 2019).

To pursue our venture of exploring the above-stated motivation, the researchers have poised to search for an answer to the following research question: *What are the sources and drivers of inflationary pressures in Sierra Leone?* To answer the above research question, we hereby set

[3] ARIMA is Autoregressive Integrated Moving Average, while ARIMAX indicated Autoregressive Integrated Moving Average with Exogenous variable accounting for X in the acronym.

ourselves to explore the three undermentioned research objectives: *(i) To examine the determinants of inflation in Sierra Leone; (ii) To utilise an econometric technique that explores the determinants of inflation, with attention focused on supply and demand-side pressure*.

Our motivation and proposed contribution to knowledge for this paper are two-fold: (i) assess the demand and supply-side impact of inflation on welfare status, and (ii) to the best of our knowledge, we are perceived to address the topic by factoring additional indicators and supported by different timelines considered to be equally influential in monitoring the BSL core mandate of price stability.

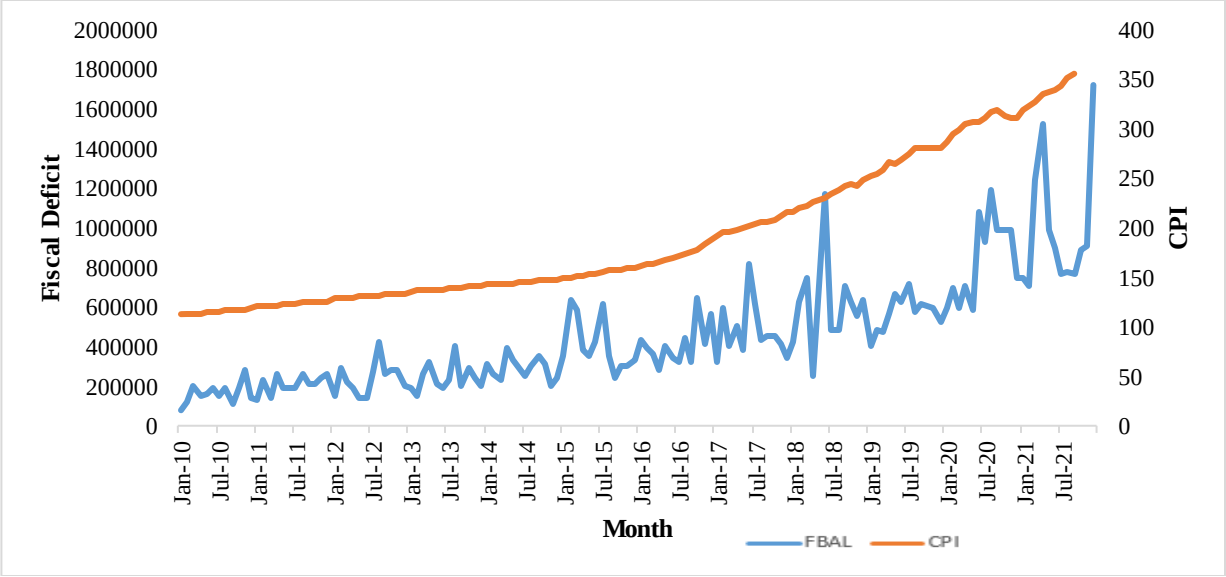
The rest of the paper is therefore organised as follows: Section two addresses stylised facts or historical evolution of inflationary pressures in Sierra Leone, while section three explores the literature on determinants of inflation, sub-sectioned into empirical and theoretical literature. Section four explores data types and sources, which is further informed by the choice of theoretical framework and methodology to be utilised for the empirical estimation. Section five provides evidence of the model results and analysis.

## 2. Historical Evolution of Inflationary Pressures in Sierra Leone

Inflation is a topical discourse in Sierra Leone given its impact on eroding decent welfare conditions for citizens and its likely threat to macroeconomic stability. Historically, Sierra Leone enjoyed long-term economic management under British colonial rule (Luke & Riley, 1989). The deterioration of economic well-being could be traced back to the former regime's insistence on hosting the then Organisation of African Union (OAU) meeting in 1980, which somehow depleted the country's reserve without much scope for diversification in generating sufficient revenues to support buoyant economic management (Kallon, 2004; Luke and Riley, 1989).

Inflationary pressure in Sierra Leone could be linked to shocks about civil unrest, economic high unemployment and persistent trade deficit, which started manifesting themselves in the domestic economy as early as the 1980s to the late 1990s. This insecurity is beaconed on the socio-economic crises endemic to the country, which also affected local productivity as real sector operations were almost kept to zero, thereby eroding citizens' hope of decent well-being and a disincentive on the part of foreign investors to pursue business operations in Sierra Leone (Kallon, 2004, Bangura, Caulker and Pessima, 2012).

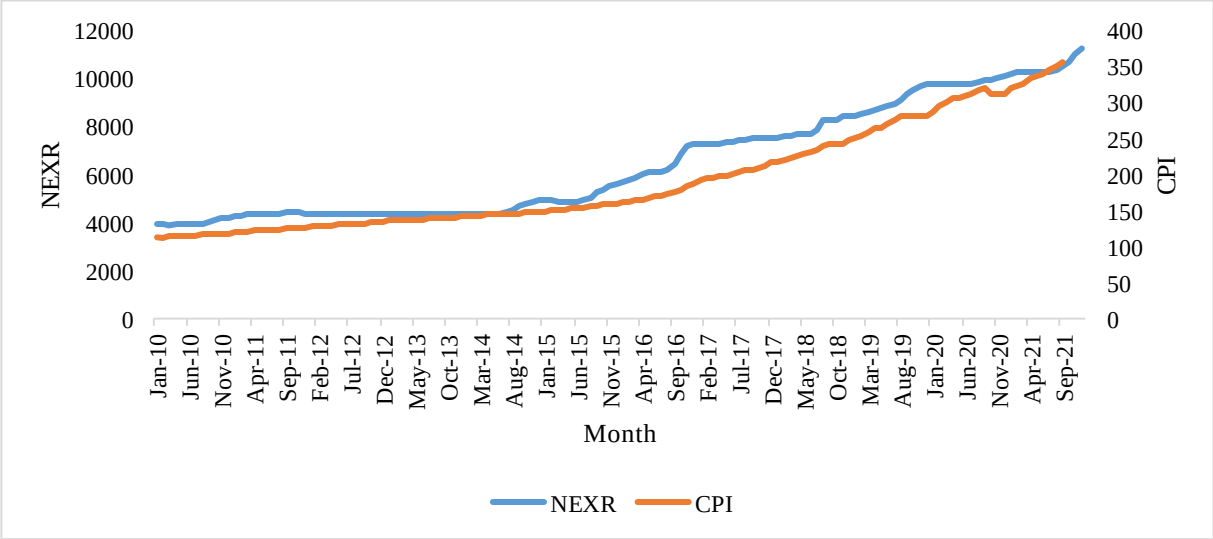
**Figure 1: Co-movement of CPI and Fiscal Deficit (FD)**




**Source**: *EVIEWS Output*

Concerning Figure 1 above, it could be seen that inflationary pressure in the country is directly linked to a myriad of factors, and more specifically bloated Government expenditure / Fiscal Balances, which seem to have fluctuated upwardly over the past years. Apart from a one-time positive shock the country experienced in the Iron Ore boom during the period 2012-2013, which is depicted by a somehow stable and low expenditure pattern in government expenditure and slow movement in inflationary movement (a reference to Figure 1), the lack of foresight by the then regime to diversify the economy also resulted in a mixed outcome for the economy throughout the twin-shock crises. This twin shock (epitomized by the emergence of the Ebola and mudslide that took place around 2014 and 2017 respectively), could also explain the current state of inflationary pressure in Sierra Leone.

## Figure 2: Co-movement between CPI and NEXR




Source: EVIEWS Output

Concerning Figure 2 above, we could see that inflation is moving in tandem with NEXR (proxy by Exchange Rate). The reason for this could be linked with factors such as the persistent

trade deficit witnessed in the country over the past two decades and supported by an unproductive real sector, which has exacerbated consumers' high appetite for imported goods and services. Such a situation also has a direct impact on exchange rate depreciation, translated into a high pass-through on prices paid to secure forex in settling import bills. This is also consistent with recent empirical research outcomes on inflation dynamics and exchange rate pass-through explored by researchers like Jackson & Jabbie (2019) and Bangura, Caulker & Pessima, (2012).

The continued state of shock perpetrated in the global economy, resulting from the emergence of the COVID-19 pandemic has manifested itself as a catalyst for inflationary pressures in the Sierra Leone economy - this will continue to pose risk to the economy given the lean state of real sector operations (Warburton and Jackson). As already emphasised in a recent study carried out by Santacreu and LaBelle (2022), supply-chain disruption of goods and services will continue to take a toll on the Sierra Leone economy through anticipated hikes in prices of inelastic goods like rice, typically considered as the country's major staple diet. As shown in Figure 2 above, exchange rate and inflationary crises will continue to manifest themselves in all areas of the economy on account of the persistent dependence on imports to sustain domestic consumption and the country's vulnerability to both internal and external shocks. On that note, it is therefore the intention of this paper to utilise an appropriate methodology to examine the determinants of inflation in Sierra Leone, with attention focused on both supply and demand-side factors (notably exchange rate, fiscal balance and currency in circulation).

## 3. Literature Review

The purpose of this section is to inform the authors' understanding of earlier produced works about inflation determinants. This will make it possible for the authors to carve their approach on how best to add value to knowledge, geared towards informing effective policy formulation at the Bank of Sierra Leone. On that note, the section is hereby divided into two sub-sections, namely Theoretical and Empirical literature as detailed below.

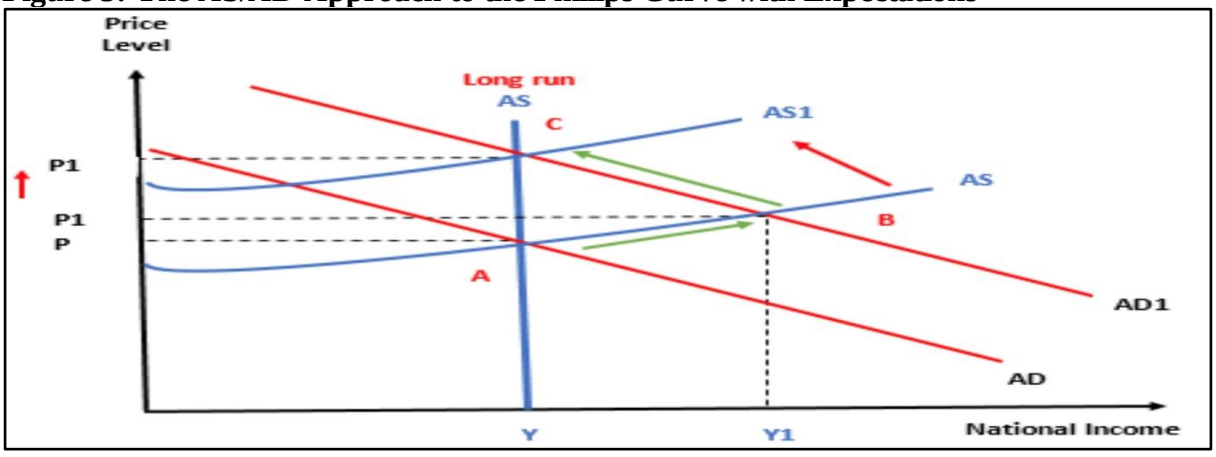
### 3.1. Theoretical Literature

Various schools of thought have been proposed to explain the root causes of inflation in the global economy. In general, this can be linked to four established theories – "*Theory of money, Keynesian, Cost-Push and Structuralist*" (Frisch, 1990). Each of these is considered valid in accounting for the volatile state of inflation in the global economy. Their influences could be thought of as interlinked, with the emphasis on structural problems endemic to most economies, specific to small open-economy like Sierra Leone.

Keynesian theory gained popularity in the 1930s and the understanding is that both the central bank and government intervention should be used to spur economic growth and decent well-being for citizens (Jahan, Mahmud and Papageorgiou, 2014). Keynesian thinking believes that aggregate demand – considered to be the sum of expenditures categorised on the bases of households, businesses, and government – is construed as a catalyst to economic development and stability.

The development of the Keynesian theory is rooted in the Phillips Curve (a reference to Figure 3)[4], which investigated the relationship between changes in money wages and the rate of employment, perceived as an innovation in modern economic thought, particularly about inflation dynamics (Phillips, 1958).

**Figure 3: The AS/AD Approach to the Phillips Curve with Expectations**




*Source: Adopted from Global Economics (Online)*

In contrast, the monetarist approach, akin to the "*Quantity Theory of Money*" is considered critical to human understanding of inflation discourses in macroeconomic foundation – such assertion can be traced back to the 1970s, particularly with the effort of Milton Friedman's theoretical application of two of his popular papers: "*A Theoretical Framework for Monetary*

[4] Using the analogy of the Aggregate Supply (AS) and Aggregate Demand (AD) approach as shown in Figure 3, the Phillips Curve provide an illustrative explanation to illustrate the Keynesian theory of inflation as depicted in Figure 3. For a simple illustration, we will assume that the economy is at an equilibrium state, set at Y. Therefore, an attempt to increase government expenditure will result in a shift from AD to AD1, thereby causing income to increase to Y1, with a trade-off for employment, which is set to fall in the short-run. This also makes it possible for households to build their expectations into a possible wage bargaining - an ultimate increase in cost of wages, thereby causing Aggregate Supply to move from AS to AS1. The end result is a move to equilibrium state (Y), but trading-off at higher price level to P2.

*Analysis*" (1970) and "*A Monetary Theory of Nominal Income*" (1971). On reflection of works produced so far that pertain to the monetarist theory of inflation, Frisch (1990: 90-91) made tremendous effort to summarise three hypotheses commonly reappearing in theoretical discourses on the causes of inflation and these include: (i) Inflation is, in essence, a monetary phenomenon, (ii) Keynesian theory, which monetarists equate with a simple Phillips curve without adjustment for expectations, cannot explain the problem of inflation, especially the acceleration of inflation, and (iii) The rate of growth and the acceleration of the money supply explain the rate of inflation and its acceleration respectively. Linking the above discourses to Fisher's version, the monetarist approach can be expressed using a simple mathematical illustration: $MV = PT$. Where M is the Money Supply, V is the Velocity of Circulation, P is the Price level and T is Transactions, though difficult to measure, it can be construed as a substitute for National Income, which is equal to the total quantity of goods and services produced.

The third type of inflation addressed in this section is the Cost-Push theory of inflation. This type of inflation is said to occur when an economy experiences some form of negative cost shock – various authors have proffered an explanation about the underlying causes of such type of inflation in an economy (Frisch, 1990; Totonchi, 2011). Attributes of cost-push inflation include though are not limited to the following: i) Commodity price shocks, particularly Oil prices on account of incidences like wars and pandemics as witnessed with COVID-19, ii) Increases in agricultural prices, iii) Rising wage costs and iv) Exchange rate depreciation / imported inflation.

Last but not least, the Structural Theory of inflation is distinguished from the others on account of structural maladjustments endemic to many economies around the world (Frisch, 1990). From the perspective of Western/developed economies, the structural theory of inflation is an attempt to explain the long-run rise in price levels (Streeten, 1962; Baumol, 1967). The Structural theory of inflation is also based on the notion that efforts to reduce money wages can be emphatically strong, but almost an impossible venture. In this situation, resistance to wage reduction relative to adjustment in the supply of, and demand for labour across occupations and industrial activities would need to be accomplished through a corresponding rise in wages – an exception to this is workers considered to be in weak market positions. Such a situation of wage inflation as elucidated by Frisch (1990: 157) is said to be proportional to the rate of structural change in an economy.

The above theoretical discourse has provided a platform to examine the sources of inflationary pressures economies experience around the world. The structural theory of inflation seems to be highly common among developing economies and Sierra Leone is no exception to such problems – this could be attributed to structural factors such as weaknesses in real sector operations, the dominance of external shocks, and other factors connected with demand and supply-side pressures (Bangura et al, 2013; Jackson and Jabbie, 2020; Argy, 1970). The next sub-section provides a platform for exploring knowledge acquisition that pertains to empirically published research on the determinants and sources (both supply and demand-side pressures) of inflation.

### 3.2. Empirical Literature

This section specifically focuses attention on a review of empirical literature that borders on works already produced in the topical area, which are geared towards informing the authors' knowledge on the approach and value addition on the determinants of inflation in Sierra Leone. To start with, Korsu (2014) pursued a study to investigate the inflationary effects of fiscal deficit in Sierra Leone using a simulation approach. The study is motivated based on issues about fiscal

deficits, the rising government debts and monetization of fiscal deficit that have become major concerns of policymakers and academics in the Sierra Leone economy. It is thought that the persistence of fiscal deficit, which seems to have gained traction since the 1970s has resulted in expansionary monetary policy - an incitement of inflationary pressure on the economy that also defeats the core mandate of price stability. The study utilised annual data from 1971 to 2012, with ARDL as the estimation model to account for dynamics (lag impact of variables) on inflation. In addition, policy simulations were carried out for the period 2015-2017, with unit root tests indicating that all variables are stationary. The estimation outcome showed that inflation is determined negatively by real GDP growth and positively by both money supply growth and exchange rate depreciation. Policy recommendations from the study noted the following observations: (i) that in the interest of attaining low inflation, the conduct of monetary policy and the underlying budget deficit will depend on the degree of exchange rate depreciation and the real GDP growth in the economy.

Bane (2018) investigated the dynamics and determinants of inflation in Ethiopia using annual data from the National Bank of Ethiopia (NBE), the Central Statistical Agency (CSA) and the Ministry of Finance and Economic Cooperation (MOFED). The methodology utilised was ARDL, with emphasis on the monetarist and structuralist views of inflation. The study outcome showed that the major determinants and dynamics of inflation in Ethiopia are both monetary sector and structural factors. The ARDL model indicated monetary determinants of inflation to include money supply and the real interest rate. The outcome specifically proved inflation to be both a monetary (proxied by money expansion via credit and money printing; government spending and the real interest rate) and structural phenomenon (mainly agricultural shocks). The main recommendation from the study point to the fact that the government of Ethiopia should adopt conservative fiscal and monetary policies, while at the same time enhancing the scope for growth, which have implications for reducing inflationary pressures.

Anaman (2019) examined the factors underlying the inflationary phenomenon in Ghana using annual data that spanned from 1979 to 2016. The study seems to have added to the body of existing literature on inflation through the identification of short and long-run factors, which are thought to influence the inflation trajectory in Ghana. The study utilized Autoregressive Distributed Lag (ARDL) approach in a bid to establish both the long and short-run determinants of inflation based. The empirical outcome showed that price level, in the long run, is significantly determined by food crop production, crude oil prices, population, the output of goods and services and money supply, while in the short run, interest rate (proxied by policy rate) is the only variable that does not impact significantly on the price level. Error correction outcome (indicated at 60%) showed that the system adjusted itself to equilibrium level every quarter. The final recommendation from the study stipulated that policymakers must pay a high level of attention to supply-side issues in the economy rather than focusing attention on the normal orthodox approach to monetary policy.

Inim, Samuel & Prince (2020), pursued an empirical estimation to investigate other determinants of inflation in Nigeria with quarterly data spanning January 1999 to December 2018. The study examined other determinants of inflation in Nigeria using the Autoregressive Distributed Lag (ARDL) method. The empirical outcome showed that poor infrastructural development, exchange rate, political instability, corruption, and double taxation significantly instigate inflationary pressure and not necessarily money supply. The outcome, which showed long and short-run relationships also manifested a causal relationship between other determining factors and the inflation indicator. Recommendations from the study showed that non-monetary factors that instigate inflationary pressures must be controlled, while a review of security expenditure must

be regularly carried out to achieve low inflation, consistent with the single digits inflation target needed to support economic growth and development in Nigeria.

Yildirim (2021) undertook an empirical study to determine inflation expectations in Turkey using the SVAR methodology. The study examined the drivers of inflation expectations, obtained from the market participants' survey in Turkey during the period 2006Q1 - 2021Q3. Short-term recursive restrictions were imposed, which took into consideration a co-dependence of relationship in all variables. The study outcome concluded the following points: (i) that inflation expectation dynamics moved with the instinct to a range of macroeconomic shocks. (ii) that expected inflation trends upwards with a temporary/unanticipated increase on its own, as well as other variables like exchange rate, core inflation, oil prices, food prices, and interest rate shocks. (iii) based on innovation shock from impulse response functions and forecast error variance decompositions, it is observed that variation in the exchange rate is the most significant factor that influences changes in expected inflation over a longer period. Overall, the study outcome showed that exchange rate, inflation expectations shock, and oil prices substantially contribute to inflation expectation inertia in Turkey. Robustness check analysis also supported the underlying empirical outcome. Finally, the recommendation specifies that the credibility of the Central Bank of Turkey must endeavour to factor inflation expectations for consistency with its inflation targeting strategy to control inflation in Turkey as set out by the monetary policy committee.

This study seeks to add to the body of knowledge exploration by specifically paying attention to both supply and demand-side indicators (as already outlined in some of the highlighted literature (notably Jackson et al, 2019 and Anaman, 2019), with varied methodology and an expansion of the study period beyond 2019.

## 4. Methodology and Data Description

### 4.1. Methodology

#### 4.1.1 Theoretical framework

We use the decomposition of the price level into tradable and non-tradable goods in the context of the Purchasing Power Parity (PPP) and monetary disequilibrium spillover to domestic prices as the theoretical framework for the estimated inflation model, as adapted from Adu & Marbuah (2011).The choice is based on the following: (i) Goods and services in Sierra Leone fall under tradable and non-tradable goods (iii) Sierra Leone is a small open economy with floating exchange rate regime and it exports are primary products while the imports are goods with inelastic demands, including energy and food imports. Thus, changes in exchange rate expected reflect on domestic price level through the PPP, even where the relationship is not one-for-one.

In this respect, the price level is construed as a weighted average of the price of tradable goods ($P^T$) and non-tradable goods ($P^N$) as given in equation (1) in logarithmic form.

$$lnP_t = \theta(\ln P^T) + (1-\theta)(lnP^N) \qquad (1)$$

Where $0< \theta<1$ is the weight of the price of tradable goods in the price level.

Thus, according to the PPP, the price of tradable goods is given as:

$$P^T = EP^f \Rightarrow \ln \mathrm{P^T} = \ln \mathrm{E} + \ln P^f \qquad (2)$$

By cancelling out $P^f$ in Eq. 1, this can be rewritten as:

$$P^T = loge \qquad \text{Eq. 3}$$

The price of non-tradable goods,unlike the price of tradable goods, is domestically set given developments in the money market and it moves in tandem with demand in the domestic economy, dictated by money market conditions.Thus, the price of non-tradable goods is determined by the money market disquilibrium.That is, given that money supply is $M^s$ and money demand is M ($M^d$), the price of non-tradable goods is:

$$P^N = \lambda(\log M^s - \lambda \log M^d) \quad (3)$$

Where, λ is the scale factor representing the relationship between economy-wide demand and the demand for non-tradable goods. The demand for money is considered to depend on t on real income (y), interest rate(r) and inflationary expectations (E($\pi$)). Where income is the scale variable and interest rate is the opportunity cost variable as in equation (4).

$$M_t^d = f(y, r, E(\pi)) \quad (4)$$

Where y is real income, r is the nominal interest rate and $E(\pi)$ is the expected inflation rate, proxy by Risk Premium for this study. Economic theory in this case postulates a positive relationship between money demand and real income on one hand and money demand and expected inflation rate on the other hand (Adu and Marbuah, 2011). On the other hand, we also note from economic theory that there exists an inverse relationship between demand for real money balances and the interest rate. In addition to Adu and Marbuah (2011) study, we also seek to apply our understanding from Ubide (1997) and Laryea and Sumaila (2001) studies in postulating a general formulation of inflationary expectations common to Sierra Leone, hence resulting in the initiation of Eq. 6.

$$E(\pi_t) = y\big(L(\pi_t)\big) + (1 - y)\Delta log P_{t-1} \quad \text{Eq. 6}$$

Where L($\pi_t$) represents a distributed lag for agents in the economy, with backwards-looking expectations, thereby equating the distribution parameter for the process to zero (that is g = 0). This now restates equation (6) in a simplified format as shown below in Eq. 7:

$$E(\pi_t) = \Delta log P_{t-1} \quad \text{Eq. 7}$$

With the substitution of Eq. 7 into Eq. 4 and then utilising the results and also, Eq. 3 into Eq. 1 – rearrangement then produces a new price level expression as indicated in Eq. 8:

$$P_t = f(y_t, E_t, M_t, r_t, P_{t-1}) \quad \text{Eq. 8}$$

An important macroeconomic indicator that is considered influential to inflation outcome and expectations in Sierra Leone is the fiscal deficit (FD). Fiscal deficit normally leads to a temporary form of disequilibrium in the money market, which takes the form of increased use of currency in circulation, and backed by a follow-up process of an increase in lending rate in a bid to divert private sector resources to fund public sector operations. This then results in the augmentation of Eq. 7, with the incorporation of a FD indicator that accounts for the effect of deficit financing, which also spurs inflationary pressure in a country like Sierra Leone where the real sector is practically unproductive to address domestic demand.

$$P_t = f(y_t, E_t, M_t, r_t, FD, P_{t-1}) \quad \text{Eq. 9}$$

### 4.1.2 Model Specification

### 4.1.3 Estimation Technique

Drawing reference from Equation 9, an ARDL model is estimated on the basis that the unot root test results show mixture of I(0) and I(1) variables. The ARDL approach has some econometric advantages over Engle and Granger (1987) and the maximum likelihood-based approach as proposed by Johansen and Juselius (1990) and Johansen (1991) cointegration techniques. To highlight a few of these: (i) the bounds test does not require pre-testing of the series to determine their order of integration since the test can be conducted regardless of whether they are purely I(1), purely I(0), or mutually integrated. However, it does not accommodate series with orer greater than I(1). (ii) the ARDL model incorporates a sufficient number of lags to capture the data generating process, which t is from a general to specific modelling framework (Laurenceson et. al, 2008).

An ARDL model is estimated in a parsimonious form, with the preferred and final model selected based on the Bayesial Information Criterion or the Akaike Information Criterion. The final model is then transformed into an error correction format that incorporates both the short run and long run dynamic as follows.

$$\Delta lnCPI_t = \delta + \beta_1 \Delta lnNEXR_t + \beta_2 ln\Delta DLRGDP_t + \beta_3 \Delta lnFBAL_t + \beta_4 \Delta lnCiC_t + \beta_n \Delta LR_t + \varepsilon_t \quad \text{Eq. 10}$$

From the above, we hereby infer the expected signs (a-priori condition) of the composite coefficients as shown below:

$NEXR > 0$; $CIC > 0$; $LR \gtrless 0$; $RGDP \gtrless 0$ $FBAL < 0$

Note that; FBAL=Fiscal Balance; $LR = Lending\ Rate$

The change symbol (Δ) is indicative of the first difference operator and the rest of the other variables as specified in equation 12. To establish whether long-run relation exists, the bounds test procedure is by Pesaran et al. (2001) is applied. In this approach, the Ordinary Least Squares (OLS) technique is applied to obtain the short-run coefficients ( the coefficients of the first differenced variables) and the long-run coefficients ( the coefficients of the level variables). The existence of a long-run relationship is then done using the joint significance F-test test for significance of the lagged level variables. This then involves an expression of the null hypothesis of no cointegration relationship against the alternative hypothesis of the existence of a long-run relationship, which is expressed as follwos.

$H_0$:$\rho_1=\rho_n=0$ Null Hypothesis

$H_1$: $\rho_1\neq\rho_n\neq0$. Alternative Hypothesis

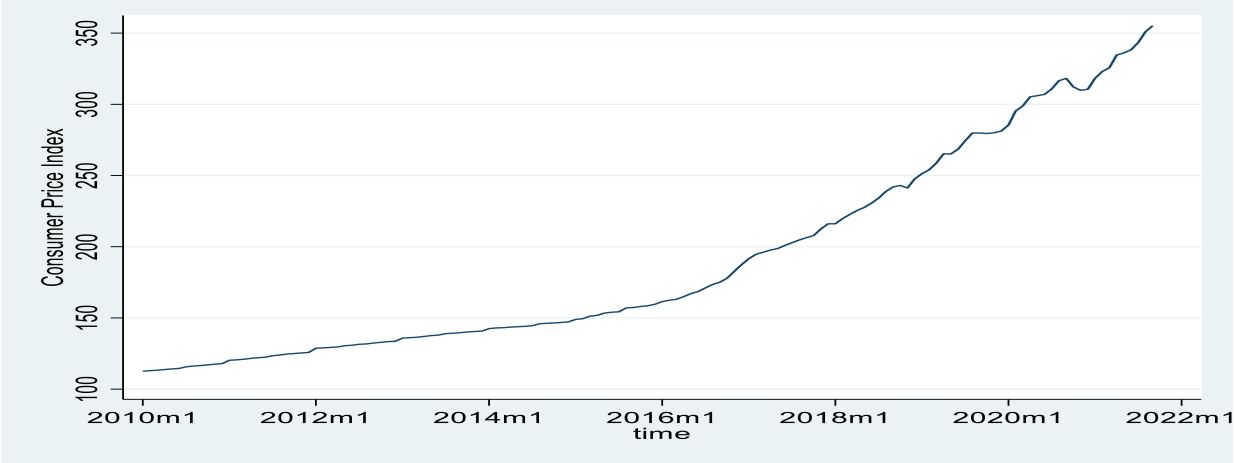
The above description evokes critical value bounds, which are based on whether the variables are I(0) or I(1) or a mixture of both – the outcome from this is a generation of two critical values for the cointegration test, where the lower critical bound accept all variables to be of I(0) order, thereby signifying no cointegration existing amongst the variables, whereas the upper bound to adopt the fact that variables are I(1).

When the calculated F-statistic is greater than the upper critical bound, we reject the null hypothesis of no cointegration. Alternatively, if the calculated F-statistic is below the lower critical bounds value we do not reject the null of no cointegration. There is also the possibility of an inconclusive decision. This is the case when the calculated F-statistic falls between the lower and upper bounds.

### 4.2.Data Description

This section describes each of the variables, with the justification of their relevance to the study. Below is a narrative of the indicators:

**Figure 4: Consumer Price Index**

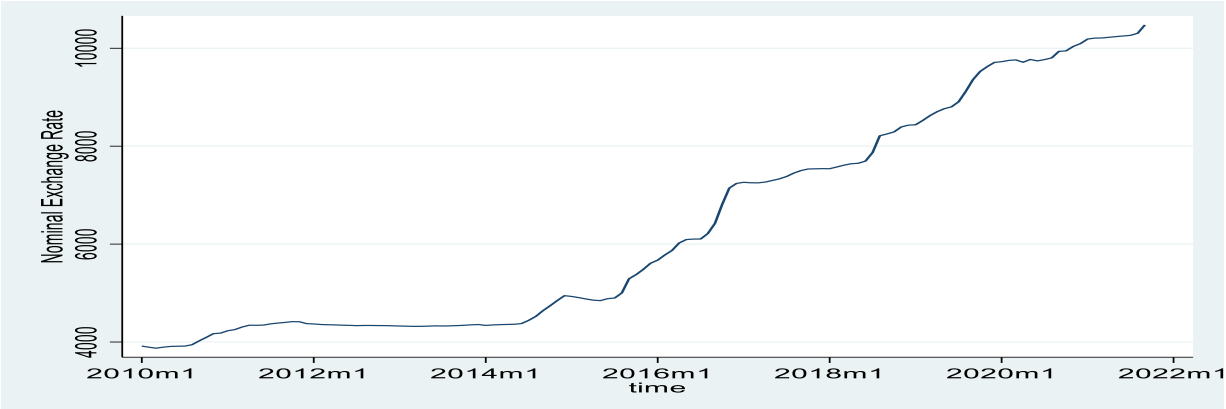



Source: BSL

Figure 4 above depicts the CPI for Sierra Leone, which is a proxy for inflation and it is the headline component in a basket of goods produced in Sierra Leone. Information produced in Figure 4, shows that inflationary pressure is something very common in the Sierra Leone economy given the deterministic pattern of the graph, which is consistently rising over the years.

**Nominal Exchange Rate (LNEXR)**: This is the amount of domestic currency needed to purchase foreign currency. In a country like Sierra Leone, NEXR is a supply-side pressure factor, which is highly determined by consumers' appetite to demand more imported items to meet their consumption needs. The almost deterministic pattern of the graph as shown in Fig. 5 indicate that NEXR has a high depreciation rate, which makes it easier for higher prices to be filtered into all areas of the domestic economy.

**Figure 5: Nominal Exchange Rate (NEXR)**

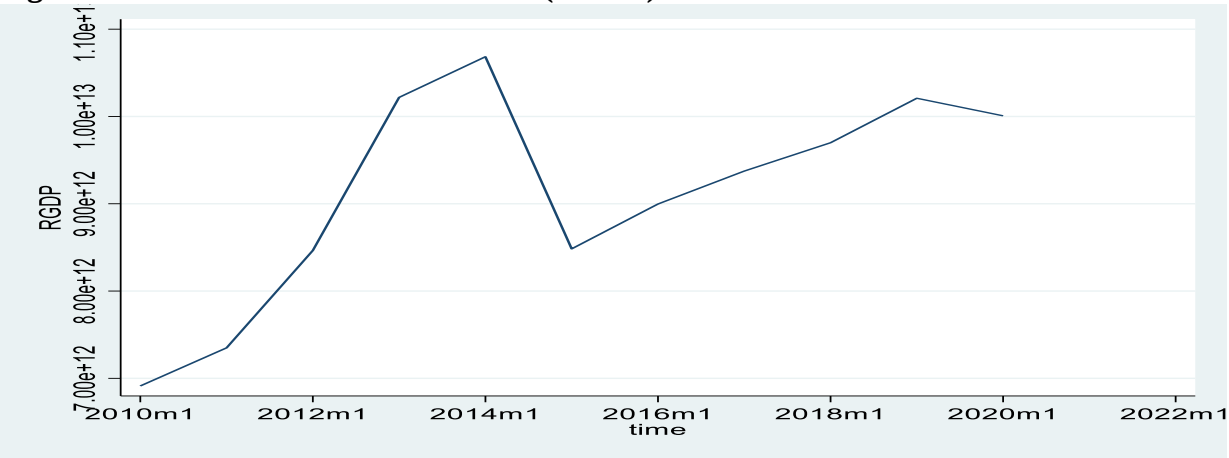



Source: BSL

**Real Gross Domestic Product (LRGDP)**: This indicator as shown in Fig. 6, is a measure of the value of economic outputs, which is adjusted for price changes (in short, inflation or deflation). This adjustment portrays an indication of the value of money measured in nominal GDP terms,

and typically as total output. In short, the GDP comprises: "*consumer spending, industrial investments, excess of exports over imports and government spending*".

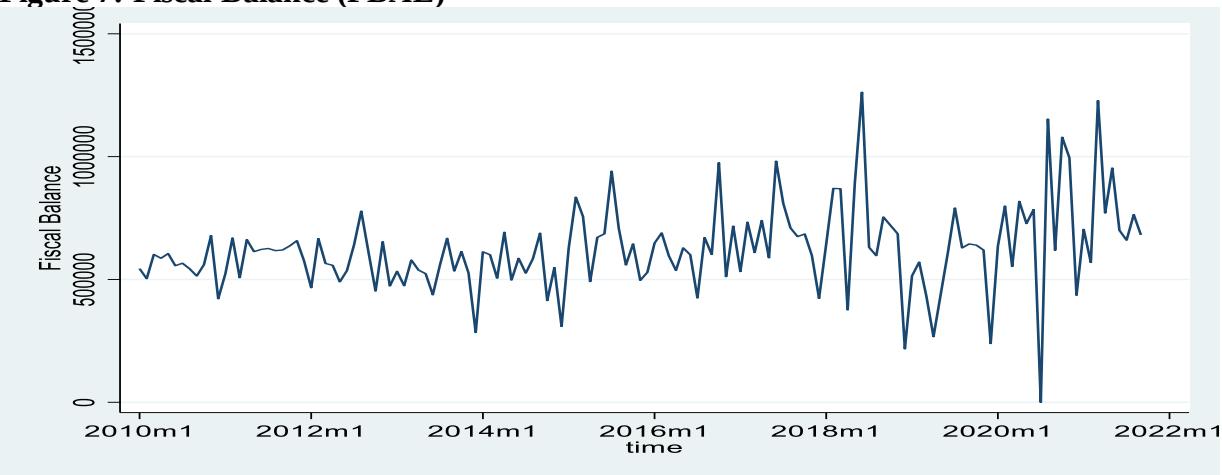
**Figure 6: Real Gross Domestic Product (RGDP)**




Source: BSL

**Fiscal Balance (FB)**: In short, Figure 7 is the difference between the Total Revenue and Total Expenditure of a country. It gives an indication of the government's appetite to spend, which is motivated by various factors – in general, government's borrowing appetite may also be dictated by the fact that a country may not be sufficiently capacitated to generate enough revenues to meet planned expenses and hence, the outcome to access funding is through domestic funding – typical example in the case with Sierra Leone is through the money market (technically the T-Bills). Where the scope of borrowing is not fully met by the commercial banks, the central bank may step in, which is also a catalyst for inflationary pressure.

**Figure 7: Fiscal Balance (FBAL)**




Source: BSL

**Currency in Circulation (LCiC)**: Based on Fig. 8, CiC is the amount of money that is represented in paper form or coins within a country, considered physically in use to conduct a transaction by customers and businesses. More specifically, CiC is all of the money issued by the Bank of Sierra Leone less cash removed from the banking system. It is part of the total money supply in a system,

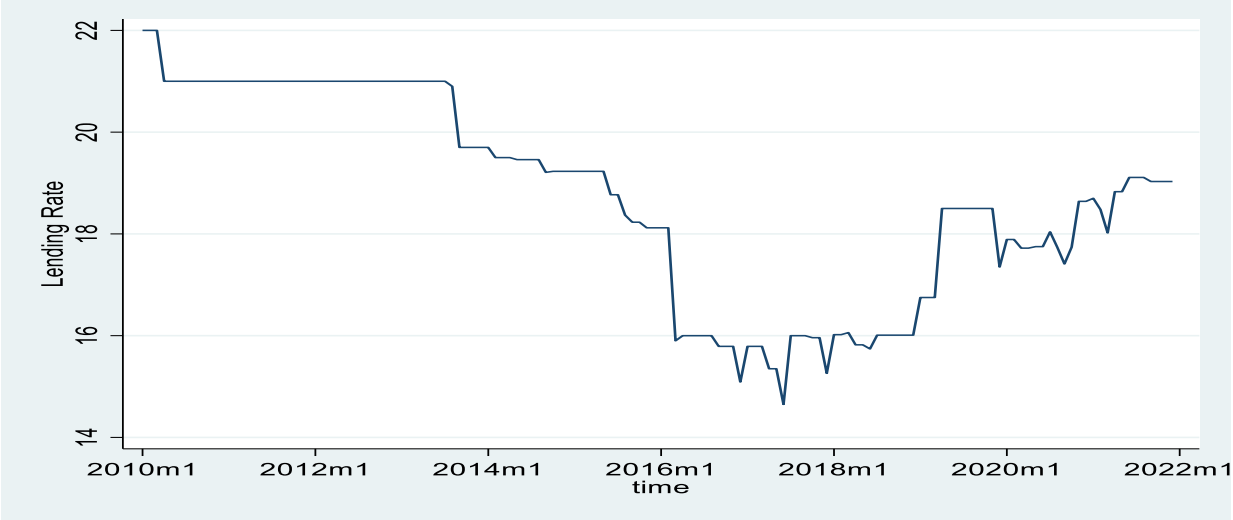
of which the remaining parts will have already been stored in checking and savings account. Fig. 8 shows a fluctuating rise in CiC, which also relates to continued pressure in the exchange rate market and the need for consumers to demand more money to address their wants.

**Figure 8: Currency in Circulation (CiC)**


Source: BSL

**Lending Rate (LR)**: Concerning Fig. 9, LR is the amount that is charged by lenders, particularly high street commercial banks for a given period as a percentage of the amount lent or deposited by a customer. In most cases, the total interest charged will depend on the duration of the service or even the status of the customer (classified as high or low risk). The lending rate as provided in Fig. 9 is a reflection of the rate charged by commercial banks in Sierra Leone over the study period, which is 2010M1-2021M12. On reflection of Fig. 9, rates moved to their lowest around 2017 and in 2020, which could be on account of some shock in the economy and the BSL's unconventional Monetary Policy measure to cushion the adverse impact of the COVID-19 pandemic on citizens' welfare.

**Figure 9: Lending Rate (LR)**




Source: BSL

## 5. Model Estimation Results and Discussion

The Summary Statistics as presented in Table 2 has 120 observations, with all variables showing reasonably low outcomes for mean, median and other indicators like Median, Maximum, Minimum and Standard Deviation. To normalise the interpretation, a good number of the variables were logged except for Lending Rate (LR), which was done at a level state. Standard deviation indicates dispersion or spread in the series, which are all within the reasonable value of less than one except LR because its value was not logged.

**4.3.Table 1: Unit Root Test Outcome for Break-Point Unit Root**

| Variable | Dickey Fuller GLS (DF-GLS) | | Perron-Vogelsang (PV) | | Clemente-Montanes-Reyes (CMR) | | Conclusion Based on DF-GLS, PV & CMR |
|---|---|---|---|---|---|---|---|
| | Deterministic Component | Integration Order | Break Point | Integration Order | Break Point | Integration Order | |
| Consumer Price Index (CPI) | Trend | I(1) | 2020m11 | I(2) | 2017m3 & 2019m9 | I(1) | I(1) |
| Nominal Exchange Rate (NEXR) | Constant + Trend | I(1) | 2017m2 | I(1) | 2017m1 & 2020m1 | I(1) | I(1) |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Real Gross Domestic Product (RGDP) | Constant + Trend | I(2) | 2013m2 | I(1) | 2013m2 & 2015m2 | I(1) | I(1) |
| Currency in Circulation (CiC) | Trend | I(1) | 2019m10 | I(2) | 2017m10 & 2018m10 | I(k) | I(1) |
| Fiscal Balance (FBal) | Constant | I(0) | 2020m5 | I(1) | 2018m2 & 2020m5 | I(k) | I(0) |
| Lending Rate (LR) | Constant + Trend | I(1) | 2016m1 | I(2) | 2016m1 & 2017m5) | I(2) | I(1) |

**Note (from Table 1 above)**: L=level, 1D=1st Difference, 2D=2nd Difference, while I(K) denote series is not stationary even after 2nd differencing. All unit root estimates are determined at lag 1.

### 4.4. Summary Statistics

**Table 2: Summary Statistics**

| | LCPI | LNEXR | DLRGDP | LFBAL | LCIC | LR |
|---|---|---|---|---|---|---|
| **Mean** | 5.095411 | 8.617325 | 2.58E+10 | 13.63645 | 13.85905 | 18.74108 |
| **Median** | 5.005320 | 8.490337 | 3.76E+10 | 13.64966 | 13.92483 | 19.23000 |
| **Maximum** | 5.654067 | 9.182535 | 1.46E+11 | 14.22592 | 14.65178 | 22.00000 |
| **Minimum** | 4.727299 | 8.262174 | -1.83E+11 | 13.04529 | 13.01194 | 14.65000 |
| **Std. Dev.** | 0.273417 | 0.289396 | 8.12E+10 | 0.174070 | 0.432056 | 2.153102 |
| **Observations** | 120 | 120 | 120 | 120 | 120 | 120 |

### 5.6. ARDL Estimation

Appendix 1 shows the initial output from the ARDL model and its specified variables. The variable LCPI (Lag1) was proven to be statistically significant at the 5% level in explaining current inflation (CPI). Surprisingly, the LNEXR was not statistically significant at the 5% level in explaining the current exchange rate (NEXR) and even at the first lag. The RGDP was statistically significant at the 5% level in explaining current inflation pressure. The outcome for Fiscal Balance (FBAL) shows the delayed level of statistical significance, which could be explained on the basis that government continued deficit financing (also explained as expansionary financing) has the capability of crowding out private sector investment – this can dictate the pace of interest rates in the money market, while at the same time reducing the scope for real sector investment. The significant outcomes from six dummies indicate their high influence in determining inflation

outcomes in Sierra Leone – the coefficient values from two of the dummies are negative, which is in line with the prior condition.

By interpretation, it implies that the country will continue to depend on imports in a bid to support the domestic consumption patterns, which in itself could incite inflationary pressure as the pass-through effect of price change can be effected rapidly. LCIC also show a high level of significance at lag 1 and 2. Finally, LR shows lagged level of significance, which conforms with a-prior expectation, indicating that an increase in inflation and Lending rate works oppositely.

Overall, the model was proven to have satisfactory explanatory power as reflected in the R-square value, which shows that over 90% of the variation in the dependent variable is explained by the independent variable. The combined F-Statistic value also confirms that the independent variables are jointly significant in explaining the dependent variable, which in this case is CPI. The negative or a-prior expected signs for Lending Rate (LR) and Real Gross Domestic Product (RGDP) at the level and that of FBAL at lag 3 could be interpreted as very strong and strongly exogenous, respectively in explaining a stable relationship with CPI (a proxy for inflation).

**5.7. Table 4: Bounds Test Cointegration**

F-Bounds Test — Null Hypothesis: No levels of relationship

| Test Statistic | Value | Signif. | I(0) | I(1) |
|---|---|---|---|---|
| F-statistic | 31.00416 | 10% | 2.08 | 3 |
| K | 5 | 5% | 2.39 | 3.38 |
| | | 2.5% | 2.7 | 3.73 |
| | | 1% | 3.06 | 4.15 |

The F-statistic for the model is 31.00416 as shown in Table 4 above, which is more than the upper critical bound (3.73) at the 5 percent significance level. This suggests the existence of a long-run convergent relationship between CPI and the chosen deterministic inflationary variables. Since the model exhibits long run convergence, we, therefore, proceed to analyse the Static long-run relationship for the model.

### 5.8. Static Long-Run Results

The existence of a long-run relationship between the Consumer Price Index (CPI) and its explanatory variables suggests the estimation of long-run coefficients and short-run dynamic parameters. The estimation of the ARDL model is based on the Akaike Information Criterion (AIC). The static long-run results and the diagnostic test statistics of the estimated model based on long-run estimates are reported in the table below.

**Table 5: Static Long Run Result**

| Levels Equation<br>Case 2: Restricted Constant and No Trend | | | | |
|---|---|---|---|---|
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| LNEXR | 1.256629 | 1.354848 | 0.927506 | 0.3560 |
| DLRGDP | 2.53E-12 | 6.13E-12 | 0.412519 | 0.6809 |
| LFBAL | -3.282223 | 7.466756 | -0.439578 | 0.6612 |
| LCIC | -0.140735 | 0.989993 | -0.142157 | 0.8873 |
| LR | -0.303944 | 0.740415 | -0.410505 | 0.6824 |
| C | 47.74027 | 120.0542 | 0.397656 | 0.6918 |
| EC = LCPI - (1.2566*LNEXR + 0.0000*DLRGDP -3.2822*LFBAL -0.1407 *LCIC -0.3039*LR + 47.7403 ) | | | | |

In the long run, none of the independent variables was statistically significant or had a statistically significant impact on Consumer Price Index (CPI) for the period between 2010M1 to 2021M12.

### 5.9. Dynamic Short-Run

Upon determining the long-run association between variables, we went further by utilising Error Correction Model (ECM) to verify the existence of short-run dynamics. The ECM general form of Equation 12 is now specified below as Equation 13:

$$\Delta lnCPI_t = \delta + \beta_1 \Delta lnNEXR_t + \beta_2 ln\Delta DLRGDP_t + \beta_3 \Delta lnFBAL_t + \beta_4 \Delta lnCiC_t + \beta_n \Delta LR_t + \emptyset ECM_{t-1} + \varepsilon_t \quad \text{Eq. 13}$$

The result from the short-run dynamics as shown in Appendix 2 are associated with the ARDL model (1, 1, 0, 4, 2, 1). The coefficient of the lagged error correction term (- 0.006312) is negative and statistically significant at the 1 per cent level. The negative and significant coefficient is an indication of a converging cointegrating relationship between CPI and the chosen explanatory variables. Equally in the short-run, the influence of the dummy on CPI is highly influential – coefficient values from three of the dummies are negative and significant, which is also in line with the prior condition. The magnitude of the coefficient implies that -0.06312 per cent of the disequilibrium caused by the previous month's shock converges very rapidly to the long-run equilibrium in the current month –the outcome from the short-run dynamics is a true manifestation of Bannerjee et al (1998) study, which states that a highly significant EC term is certainly a proof of long-run stable relationship.

### 5.10. Diagnostic Tests: LM Serial Correlation, Heteroskedasticity and Normality

To ascertain the efficiency and robustness of the model, various diagnostic tests were used as produced below. Accordingly, the outcome from the LM Serial Correlation result indicates that the Obs*R-squared (0.072755) is less than the value of the Chi-Square table (0.9643), hence we, therefore, conclude that there is no autocorrelation as indicated in Appendix 3.

In the event of proving that the model is not Heteroskedasticity, we utilised the outcome from Appendix 4 to confirm our decision. The chi-Square value shows is 18%, which indicates the absence of Heteroskedasticity from the mode. Finally, we also carried out a test to ascertain normality in the model outcomes. Appendix 5 shows evidence of the normality test outcome, which is 5.82, indicating that normality is slightly problematic for the model. This could also be on account of the some issues about structural problems in the domestic economy. However, a

5.4% percent probability could be interpreted as a very good model for explaining inflation determinants (for the chosen indicators) in the Sierra Leone economy.

### 5.11.CUSUUM and CUSUUMSQ Test Results

**Table 6: CUSUUM Test Result**

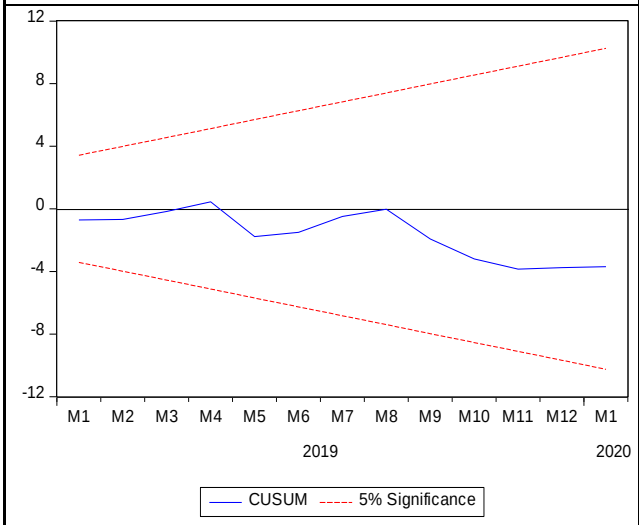
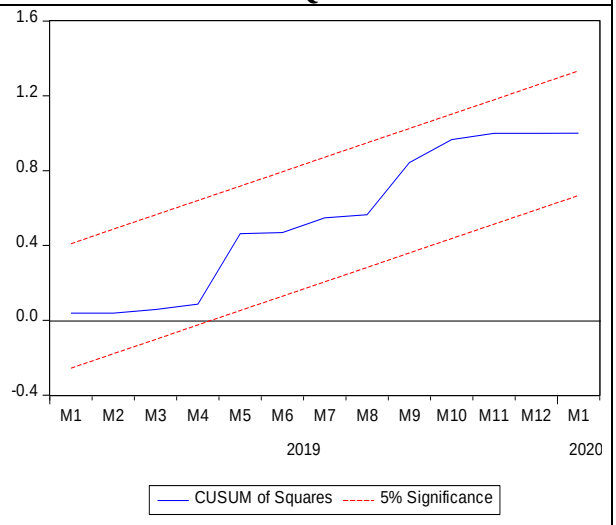



**Table 7: CUSUUMSQ Test Result**




Given the existence of structural changes in the observed variables as determined from the Structural Break Unit Root Tests, we now proceed to ascertain the model's efficiency by checking the stability using outcomes from both the CUSUUM and CUSUUMSQ tests as proposed by Brown, Durbin and Evans (1975). The result from both outcomes as indicated in Tables 6 and 7 respectively shows that the model is a good fit for the methodology used (that is, ARDL).

## 6. Conclusion

Inflation, which in this study is a proxy by CPI is very critical in determining welfare status in an economy. In Sierra Leone, inflation is a very important indicator that is set as one of the objectives focus by the central bank to ensure the economy is efficiently managed in line with the government's hope of impacting positively on growth. Given the chosen methodology, which in this case is ARDL, both short and long-run relationships between inflation and its independent variables (Exchange Rate, Real Gross Domestic Product, Fiscal Balance, Currency in Circulation and Lending Rate) were determined in the study period (2010M1-2021M12. To be more precise about the outcome of the initial unit root tests, we utilised Breakpoint Unit Root tests, which accounted for varying shocks throughout the study period. The estimated Breakpoint Unit Root Test indicates a mixture of both I(0) and I(1), which eventually lead to the decision in using ARDL as the preferred methodology for the study. We observed the presence of both short and long-run relationships existing between CPI and the independent variables. The magnitude of the coefficient, particularly with the short-run outcome indicates that -0.06312 per cent of the disequilibrium in the previous month converges again to the long-run equilibrium in the current month.

Based on the second objective, which is based on using the appropriate econometric model to determine inflation impact in Sierra Leone, we noted in the long-run, the presence of a-priori expected signs for Lending Rate (LR) and Real Gross Domestic Product (RGDP at level, while that of FBAL is at lag 3 – all the variables were interpreted to be strongly exogenous in explaining their influence on inflation dynamics in Sierra Leone. We also note that currency in circulation is

significant in the short run and negatively affects CPI at the level. This shows that inflation response to CPI is rapid and certainly impactful as a demand-side indicator in determining inflationary pressure in Sierra Leone. Given the weak state of real sector operation, it is also observed that supply-side pressure of exchange rate pass-through is not recognized in the short run, but its impact can also be felt on other variables like Fiscal Balance (FBAL) and Lending Rate, particularly in the long run. To affirm our confidence in the model outcome with ARDL, both the CUSUUM and CUSUUMSQ test outcomes at a 5% significance level confirm the stability and goodness of fit of the mode choice.

The findings from this study have unearthed some lessons for effective policy deliberation. It is therefore recommended that attention is paid to reducing the government's appetite for borrowing, which also adds pressure on domestic inflation in Sierra Leone. The increased appetite of the government to borrow will certainly have a significant influence in obscuring or crowding out private sector investment given the low risk of banks manipulating rates to their advantage. Despite the short-run lag effect of currency in circulation in response to shock in CPI, there is certainly a need for the central bank to pay closer eyes to the circular flow of money outside of the banking system, which if not monitored could also incite inflationary pressure. A possible way forward is for the central bank to introduce a modern form of the digital payment system as expected with the imminence of the National Switch, which supposedly will help tame unwanted use of spending outside of the banking system. To adequately support a buoyant real sector operation (supposedly add to the notion of structural concerns of inflation), there is a need for government to reduce its high appetite for borrowing, while at the same time encouraging economic diversification as a way of reducing the country's vulnerability to external shocks – a noticeable concern with high pass-through in the exchange rate market, which normally comes with a lag as noticed in the long-run output.

This study has provided a significant pathway to understanding the sources of inflation determinants in Sierra Leone, which seem to be mostly driven by demand and supply-side factors. However, it will be a good idea to explore other variables, while also making use of impulse response and variance decomposition as a way of understanding the gravity of shock to the system over time.

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# APPENDICES

**Appendix 1: Estimation of ARDL**

Selected Model: ARDL(1, 1, 0, 4, 2, 1)

| Variable | Coefficient | Std. Error | t-Statistic | Prob.* |
|---|---|---|---|---|
| LCPI(-1) | 0.993688 | 0.014107 | 70.43946 | 0.0000 |
| LNEXR | 0.061975 | 0.039160 | 1.582635 | 0.1168 |
| LNEXR(-1) | -0.054043 | 0.041690 | -1.296299 | 0.1980 |
| DLRGDP | 1.60E-14 | 6.47E-15 | 2.468108 | 0.0154 |
| LFBAL | -0.000691 | 0.002883 | -0.239756 | 0.8110 |
| LFBAL(-1) | -0.001328 | 0.002685 | -0.494450 | 0.6221 |
| LFBAL(-2) | -0.002792 | 0.002737 | -1.019973 | 0.3103 |
| LFBAL(-3) | -0.008294 | 0.002584 | -3.209963 | 0.0018 |
| LFBAL(-4) | -0.007614 | 0.002664 | -2.858080 | 0.0052 |
| LCIC | -0.022926 | 0.010513 | -2.180652 | 0.0317 |
| LCIC(-1) | 0.047053 | 0.013486 | 3.488913 | 0.0007 |
| LCIC(-2) | -0.025015 | 0.010617 | -2.356046 | 0.0205 |
| LR | 0.001382 | 0.001206 | 1.146584 | 0.2544 |
| LR(-1) | -0.003301 | 0.001197 | -2.757865 | 0.0070 |
| DUM2012M1 | 0.017323 | 0.004491 | 3.856857 | 0.0002 |
| DUM2016M12 | 0.014536 | 0.004789 | 3.035097 | 0.0031 |
| DUM2017M11 | 0.012253 | 0.004447 | 2.755690 | 0.0070 |
| DUM2018M1 | -0.018357 | 0.004672 | -3.929324 | 0.0002 |
| DUM2018M11 | -0.018651 | 0.004471 | -4.171822 | 0.0001 |
| DUM2018M12 | 0.016455 | 0.004784 | 3.439466 | 0.0009 |
| C | 0.301352 | 0.123279 | 2.444472 | 0.0163 |

| | | | |
|---|---|---|---|
| R-squared | 0.999789 | Mean dependent var | 5.104768 |
| Adjusted R-squared | 0.999746 | S.D. dependent var | 0.270477 |
| S.E. of regression | 0.004314 | Akaike info criterion | -7.892548 |
| Sum squared resid | 0.001787 | Schwarz criterion | -7.396773 |
| Log likelihood | 482.7140 | Hannan-Quinn criter. | -7.691269 |
| F-statistic | 22790.17 | Durbin-Watson stat | 1.990505 |
| Prob(F-statistic) | 0.000000 | | |

*Note: p-values and any subsequent tests do not account for model selection.

**Appendix 2: Short Run Estimation (ECM Regression)**

Selected Model: ARDL(1, 1, 0, 4, 2, 1)

ECM Regression

Case 2: Restricted Constant and No Trend

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| D(LNEXR) | 0.061975 | 0.035409 | 1.750288 | 0.0833 |
| D(LFBAL) | -0.000691 | 0.002581 | -0.267775 | 0.7894 |
| D(LFBAL(-1)) | 0.018700 | 0.002850 | 6.562104 | 0.0000 |
| D(LFBAL(-2)) | 0.015907 | 0.002786 | 5.708904 | 0.0000 |
| D(LFBAL(-3)) | 0.007614 | 0.002377 | 3.203054 | 0.0018 |
| D(LCIC) | -0.022926 | 0.009711 | -2.360847 | 0.0203 |
| D(LCIC(-1)) | 0.025015 | 0.009648 | 2.592749 | 0.0110 |
| D(LR) | 0.001382 | 0.001113 | 1.242164 | 0.2172 |
| DUM2012M1 | 0.017323 | 0.004286 | 4.041994 | 0.0001 |
| DUM2016M12 | 0.014536 | 0.004502 | 3.228937 | 0.0017 |
| DUM2017M11 | 0.012253 | 0.004259 | 2.877262 | 0.0049 |
| DUM2018M1 | -0.018357 | 0.004470 | -4.106576 | 0.0001 |
| DUM2018M11 | -0.018651 | 0.004250 | -4.388836 | 0.0000 |
| DUM2018M12 | 0.016455 | 0.004602 | 3.575509 | 0.0005 |
| CointEq(-1)* | -0.006312 | 0.000416 | -15.18530 | 0.0000 |

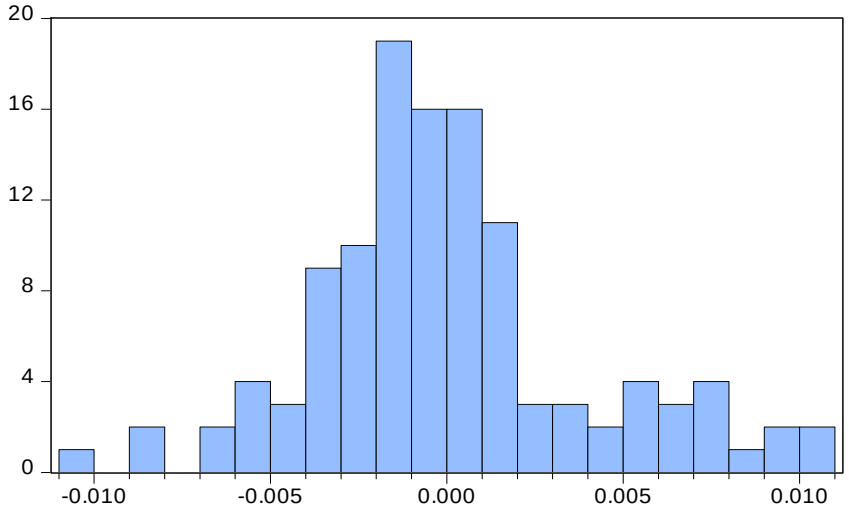
| | | | |
|---|---|---|---|
| R-squared | 0.673831 | Mean dependent var | 0.007863 |
| Adjusted R-squared | 0.629062 | S.D. dependent var | 0.006872 |
| S.E. of regression | 0.004186 | Akaike info criterion | -7.995112 |
| Sum squared resid | 0.001787 | Schwarz criterion | -7.640987 |
| Log likelihood | 482.7140 | Hannan-Quinn criter. | -7.851341 |
| Durbin-Watson stat | 1.990505 | | |

* p-value incompatible with the t-Bounds distribution.

| Appendix 3: Breusch-Godfrey Serial Correlation LM Test | | | |
|---|---|---|---|
| F-statistic | 0.029244 | Prob. F(2,94) | 0.9712 |
| Obs*R-squared | 0.072755 | Prob. Chi-Square(2) | 0.9643 |

| Appendix 4: Heteroskedasticity Test: Breusch-Pagan-Godfrey | | | |
|---|---|---|---|
| F-statistic | 1.339258 | Prob. F(20,96) | 0.1741 |
| Obs*R-squared | 25.52314 | Prob. Chi-Square(20) | 0.1821 |
| Scaled explained SS | 22.70104 | Prob. Chi-Square(20) | 0.3037 |

**Appendix 5: Normality Test**




Series: Residuals
Sample 2010M05 2020M01
Observations 117

| | |
|---|---|
| Mean | -1.59e-15 |
| Median | -0.000406 |
| Maximum | 0.010200 |
| Minimum | -0.010908 |
| Std. Dev. | 0.003925 |
| Skewness | 0.442168 |
| Kurtosis | 3.642232 |
| Jarque-Bera | 5.823245 |
| Probability | 0.054387 |

**Source**: *EVIEWS Output*