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Original Paper

Trade Openness-Inflation Nexus in Sierra Leone: Testing Romer Hypothesis using ARDL Approach

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Abstract

This study is based on Romer's proposition that there is an inverse relationship between inflation and trade openness as opposed to the narrative that argues otherwise. Therefore, the objective of this study is to examine Romer hypothesis for Sierra Leone. To achieve this objective, the study utilized the ARDL bounds testing approach to cointegration using data for the period 1980-2020. In addition, a battery of diagnostic tests were conducted to confirm the robustness of the model. The bounds test result confirm that there is long-run association between inflation and the dependent variables in this study. The associated equilibrium correction term was also significant, further confirming the existence of long-run relationship. The key findings of the study is that the Romer hypothesis holds for Sierra Leone in both the long-run and the short-run, as inflation tend to ease with increase trade openness. The control variables, exchange rate and gross domestic product were found to have a positive and significant impact on inflation in both the short-run and long-run, whereas domestic credit to the private sector impacts inflation positively in the long-run but have a disinflationary impact in the short-run. Finally, money supply and real interest rate were found to have no effects on inflation in both the short-run and long-run. At the policy level, these results show that encouraging more trade and imports that embody technology or intermediate inputs is essential in taming inflation in both the short-run and in the long–run. This outcome suggests that implementing trade liberalization policies by deepening the integration of the Sierra Leone economy to the global economy would support the price stability objective of the Bank of Sierra Leone.

Keywords

Trade openness, Inflation, Cointegration, ARDL, Sierra Leone

1. Introduction

Persistently high inflation has always been an important factor impeding growth and lowering the welfare levels of lower-income groups (Mukhtar et al., 2010). Therefore, there is a broad consensus in macroeconomic literature around the assertion that the most significant contribution central banks can make towards the attainment of macroeconomic stability and ultimately sustainable growth, is the maintenance of price stability. So, for central banks, understanding and forecasting the determinants of inflation is critically important for the conduct of an effective forward-looking monetary policy regime. Standard inflation models relying on the Monetarist, Keynesian and Structuralist propositions have identified domestic variables and allow for some aspects of supply shocks (oil and food process) as the main determinants of inflation. However, in the past decades, the world economy has witnessed significant integration of its economies within the context of globalization. Therefore ignoring this development which represents a policy shift and likely structural break in the data, can bias the determinants of inflation. Although globalization through trade liberalization comes with beneficial effects on economies through enhanced trade regimes, knowledge spillovers, foreign direct investment inflows, etc., it has also posed significant challenges for monetary authorities, to the extent that the predictive power of the basic framework central banks are using to forecast inflation has been called to question (Kristein, 2019). Thus, eroding their credibility to effectively conduct monetary policy. It is within this context that the question of whether trade openness is inflationary or deflationary has reemerged. This question continues to split opinions among academics and policymakers today, as it did decades ago. So divided are the opinions that, it is considered one of the most modern puzzles in international macroeconomics literature (Temple, 2002).

From theoretical literature, two competing theories stand out in trying to identify the channels through which trade openness affects inflation. Proponents of the spillover hypothesis maintain that higher trade openness would lead to lower domestic prices, thereby supporting the price stability objective. In support of this view, Rogoff, 1985, posits that an unanticipated increase in money supply in the economy could exert depreciation pressure on the exchange rate with a knock-on effect on domestic prices. To respond to the inflationary pressure, the monetary authority would take a contractionary monetary policy stance, thereby easing price pressures. Scholars of the new growth theory also argued that trade openness positively impacts economic growth, more so, for small open economies by fostering, greater specialization, knowledge spillovers, enhanced competition, and optimal allocation of resources which could lead to increased production of goods and services in the domestic economy, thus lowering inflation (Binici et al., 2012). Conversely, the cost-push hypothesis argues that trade liberalization increases inflation. To explain this relationship, the proponents of this hypothesis believed small open economies are more vulnerable to external shocks through imports of goods and services, which are largely demand inelastic, with significant pass-through effects on domestic prices. In addition, they assert that the more open an economy is, the less effective will the monetary authority be in combating inflationary pressures.

The existing empirical literature presents an interesting perspective on the relationship between inflation and trade openness for both developed and developing economies, though with conflicting results and with no clear consensus on the channels through which trade openness could impact inflation. There are studies that support the argument that trade openness would lead to lower inflation. Romer (1993) is credited as the pioneer in formally estimating this relationship drawing from the classic paper of Kydland and Prescott (1977) and concluded that trade openness supports lower inflation.

Following Romer, several other studies emerged to support his findings (Sachsida et al, 2003; Mukhtar, 2010; Samimi et al, 2011; and Atabay, 2016). In contrast, there other studies that found a positive relationship between openness (Kim & Beladi, 2005; Mehmet et al., 2009; Zakaria, 2010; and Evan, 2011; Thomas, 2012) and a few studies that concluded that there is no association between inflation and trade openness (Cavallari, 2001; and Feleke, 2014).

In the mid-1980s, Sierra Leone like most developing economies, embarked on a package of reforms within the framework of the structural adjustment programme to transition from a closed, interventionist economy, to an open, liberalized and market oriented economy. The motivation for these reforms was to address the structural bottlenecks that plagued the economy and to benefit from the dividend of macroeconomic and structural policies, as was the case in the earlier reformer economies. Specifically, an open and market based economic policies was expected to unlock the binding constraint to economic development and growth by attracting domestic and foreign investment, generating employment opportunity and alleviating poverty. There was a slowdown in the reform agenda during the civil war, but was accelerated after the war was declared over in 2002, as Sierra Leone reengaged with development partners to kick start the economic recovery process. An evolution of trade openness and inflation in Sierra Leone is presented is Figure 1 below. From Figure 1, trade openness and inflation seems to have a positive relationship between 1980-1989. In the 1990s, inflation and trade openness declined significantly. This could partly be attributed to the earlier dividend of the reforms and the slowdown of economic activity during the war. Between 2002-2010, trade openness picked up while inflation continued to decelerate. This observed trend seems to contradict the Romer hypothesis. From 2011-2020, both trade openness and inflation trended upward, indicating that trade openness is inflationary. We can conclude from Figure 1 that, there is no discernable relationship between trade openness and inflation over the sample period.

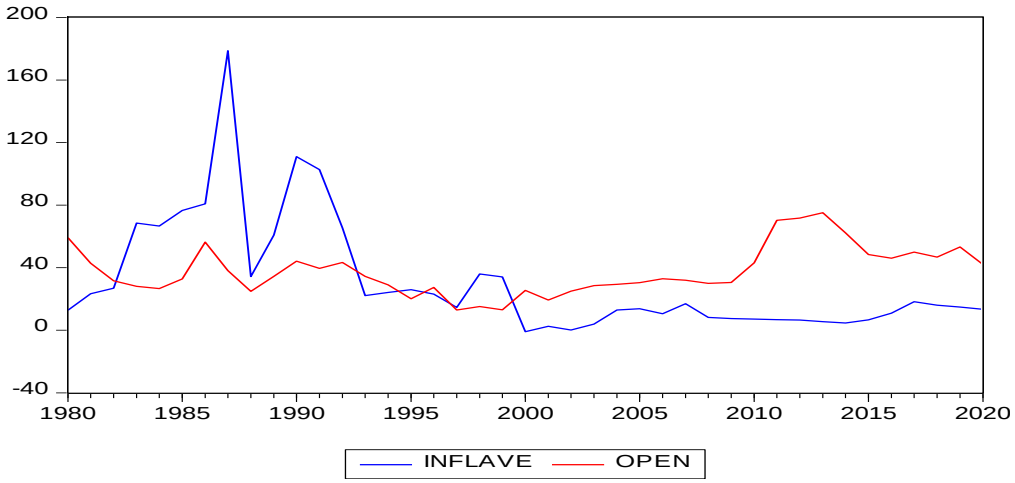

Figure 1. Inflation and Trade Openness Trend 1980-2020

From Figure 2, it can was observed that the slope of the line of best fit is relatively flat and but reflects some form of an inverse relationship between trade openness and inflation, likely supporting the Romer hypothesis. Thus, given the conflicting analysis gleaned from the two figures, a formal empirical analysis is therefore warranted to confirm the validity of Romer hypothesis in the context of Sierra Leone.

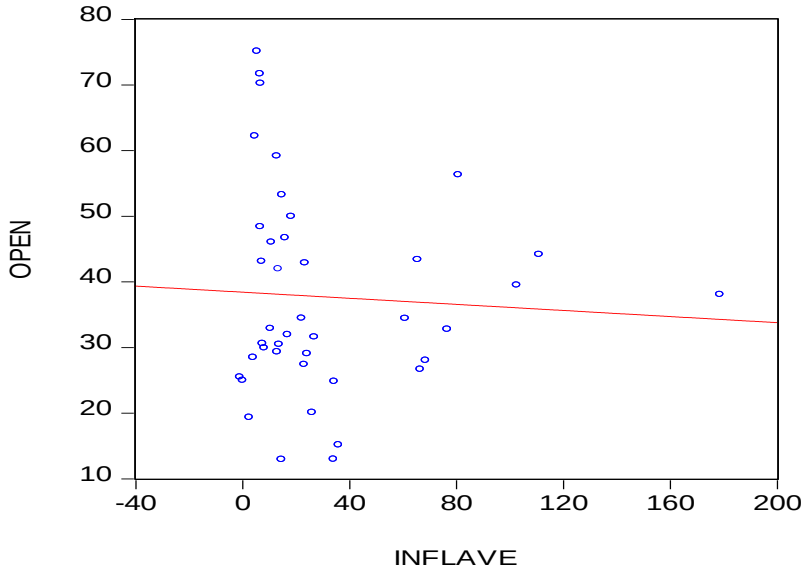

Figure 2. Scatter Plot of Trade Openness-Inflation, 1980-2020

Despite the voluminous research exploring the relationship between inflation and trade openness both developed and developing economies, to the author's knowledge, there is hardly any study that have attempted to validate the Romer hypothesis using data from Sierra Leone. Of course, a few studies are available on estimating the determinants of inflation in Sierra Leone (see, Kallon, 1994; Kovanen, 2006; Gottschalk et al., 2008; Mansaray et al., 2015; Kargbo, 2018; Ibrahim et al., 2018; and Danladi, 2020) but none of this studies incorporated trade openness into their model. Thus, it will be interesting to

investigate the relationship between inflation and trade openness for a small open economy like Sierra Leone. Therefore, this study serves to fill the existing gap in the literature for a small open economy like Sierra Leone by using an ARDL approach covering the period 1980-2020

This study reveals some interesting findings. First, that there is long-run cointegrating relationship between inflation and its determinants and that the Romer hypothesis holds for the Sierra Leone in both the long-run and the short-run, as inflation tend to ease with increase trade openness. Second, the control variables, exchange rate and gross domestic product were found to have a positive and significant impact on inflation in both the short-run and long-run, whereas domestic credit to the private sector impacts inflation positively in the long-run but have a disinflationary impact in the short-run. Finally, the remaining control variables money supply and real interest rate were found to have no effects on inflation in both the short-run and long-run.

In what follows, section two covers a brief review of the theoretical and empirical literature on trade openness-inflation nexus .Model specification, estimation techniques, and data used in the model followed in section three. Section four covers the interpretation of the estimation results focusing on the main question of whether the Romer hypothesis is valid for Sierra Leone. Finally, section five concludes with a summary of main findings and some policy recommendations.

2. Theoretical and Empirical Evidence

The debate about the relationship between inflation and trade openness started over three decades ago. This section will present an overview of theoretical and empirical studies on this relationship.

2.1 Inflation and Trade Openness Nexus- Theoretical Background

The theoretical linkage between Inflation and trade openness can be traced back to Barro and Gordon (1983) within the rules versus discretion argument in the conduct of monetary policy. The thrust of their argument is that discretionary policy leads to time inconsistent with an inflation bias. Following their argument, several other theories emerged in trying to explain this inflation-trade openness nexus, however, two theories have dominated the theoretical literature; the spillover hypothesis and cost-push hypothesis. According to the **spill over hypothesis**, higher trade openness is associated with lower domestic prices (Romer, 1993). This view was also supported by (Rogoff, 1985) who posit that the inverse relationship could be due to unanticipated monetary expansion which could trigger real exchange rate depreciation with pass-through effects on prices. In the face of this development, the monetary authority would be motivated to restrict monetary expansion and thus lower inflation. In addition, proponent of the new growth theory conclude that trade openness reduces inflation. This works through its positive impact on economic growth achieved by enhanced competition and optimal allocation of resources. Finally, trade expansion could shift the country's production possibilities thereby leading to an efficient production level translating into lower inflation (Binici et al., 2012). Conversely, the **cost-push hypothesis** advanced the idea that trade liberalization increases inflation. To explain this relationship, the proponents of this hypothesis believed that small open economies a more vulnerable to external shocks

through imports of goods and services, which are largely demand inelastic, with significant pass-through effects on domestic prices. In addition, they assert that the more open an economy is, the less effective will the monetary authority be in combating inflationary pressures.

2.2 Empirical Evidence

The past decades have witnessed a considerable piece of empirical work dedicated to understanding the relationship between trade openness and inflation in both developed and developing countries using cross-section, panel, and time series data with conflicting outcomes. Romer (1993) is credited for pioneering a study that provided the empirical foundation of the nexus between trade openness and inflation. He utilized cross sectional data of 114 economies over the Post-Bretton Woods period and concluded that there is negative relationship between trade openness and inflation. Following Romer, several other authors have estimated this relationship with varying outcomes; studies in support of Romer hypothesis, those who disagree with Romer's assertion and those who do not find any relationship between the two variables.

In support of Romer, Sachsida, Carneiro, and Loureiro (2003) using 152 countries between 1950 and 1992 using various estimations such as the fixed effect, random effect and maximum likelihood estimations, confirmed the hypothesis that there exists a negative relationship between trade openness and inflation. They have proven that the result holds regardless of the samples of countries and time and hence concluded that the countries with greater openness in trade have a less inflation rate. Mukhtar (2010) in studying the nexus between openness and inflation in Pakistan using a multivariate cointegration and a vector error correction model with data covering the period from 1960 to 2007, finds that there is a significant negative long-run relationship between inflation and trade openness, thus supporting the existence of Romer's hypothesis.. Similarly, Samimi et al. (2011) utilized the ARDL Bounds test approach to test the Romer hypothesis for Iran with data spanning 1973-2007. The result shows that openness has a negative and significant effect on inflation in the short-run but its effect in the long-run is not significant. A study by Ojoko et al. (2014) using VECM model covering the period from 1970-2010 to test the relationship between openness and inflation in Nigeria, concluded that there exists a long- run negative relationship between openness and inflation in Nigeria. Atabay (2016) conducted a time series study for the Turkish economy to determine the nexus between inflation and openness. The results of the study showed a negative association between inflation and openness thus, this study confirmed the existence of Romer's hypothesis in the Turkish economy.

In contrast, there are a plethora of studies that found a positive relationship between trade openness and inflation. Among these is the work by Terra (1998), who used a sample of 20 countries divided into four distinct categories based on their level of indebtedness. The conclusion from this study was that the Romer hypothesis hold for severely indebted countries in Latin America but did not hold for moderately and less indebted countries. Using panel data for 62 economies which consists of 28 OECD and 34 developing economies and selected on the basis of central bank dependency index form 1947 to 2002 to examine examined the relation between inflation and trade openness, Kim and Beladi (2005)

found a positive relation among prices and openness for advanced economies. Mehmet, Esener and Darici (2009) who examined the effect of trade openness on inflation for 11 developing countries from 1980 to 2006 and finds that openness have positive effects on inflation. The findings of the study Zakaria (2010) by using Generalized Method of Moments (GMM) with annual time series data from 1947 to 2007 for Pakistan, found a positive relation between openness and inflation in Pakistan. Furthermore, Evans (2011) proposed that trade openness enhanced country's incentive to create inflation by estimating data through regression from 1973 to 1987 and 1988 to 2002. He concluded that openness was inflationary between developed countries in which monetary policy can roughly approximated by controlling for imperfect competition and inelasticity of labor supply within country. Studies by Mahmoudzadeh and Shadabi (2012) examined the impact of openness on inflation in selected countries in Middle East and North Africa (MENA) region and concluded that openness leads to high inflation .Thomas (2012) examines the relationship between inflation and trade openness for 8 Caribbean countries during the period of 1980 to 2009. The results show that trade openness positively affects inflation and validates the notion that the Caribbean countries are vulnerable to external shocks.

Although the empirical evidences highlighted above support some kind of a relationship (positive or negative) between trade openness and inflation, there are few studies that found no relationship between trade openness and inflation. For example, Cavallari (2001) using panel data comprising 53 developing countries at different locations from 1975-2002 found that trade openness does not have any effect on inflation if a country effects are controlled for, but the lag money growth has significant negative relationship. Feleke (2014) investigated the nexus between openness and inflation in Ethiopia using time series data for the period 1970 to 2011. Using the auto regressive distributed lag (ARDL) model his findings contradicted the Romer hypothesis as trade openness effect on inflation is insignificant not just in short-run but also in long-run.

2.3 Synthesis of the Reviewed Literature and Gap

From the reviewed theoretical literature, it is evident from the spillover and the cost-push hypotheses that there is no definitive position on the relationship between trade openness and inflation. In addition, despite the extensive empirical evidence on the trade openness and inflation relationship, the direction of the impact of trade openness on inflation is still mixed and inconclusive While some studies founds a negative relationship in support of Romer, others studies suggest an inflationary impact of trade openness and a few studies found no relationship between the two. Thus, there is the need to further explore the empirical relationship between these variables.

Specifically for Sierra Leone, although a couple of studies have attempted to estimate the determinants of inflation and the transmission of external shocks to domestic prices (see Kallon, 1994; Kovanen, 2006; Gottschalk et al., 2008; Mansaray et al., 2015; Kargbo, 2018; and Danladi, 2020), in these studies the issue of inflation-trade openness nexus is mostly ignored. To the author's knowledge, the Romer hypothesis is yet to be tested using data from Sierra Leone, which leaves a gap in the literature. Therefore, this study serves to fill the existing gap in the literature for a small open economy like Sierra Leone.

3. Methodology and Data

3.1 Model Specification

In order to determine the relationship between inflation and trade openness in Sierra Leone for the period 1980-2020, this paper adopted and modified the model in the work by Mukhtar (2010). The model in this study is therefore specified as follows:

$$\boldsymbol{INFLAVE_t = \beta_0 + \beta_1 OPEN_t + \delta X_t + \varepsilon_t} \quad (1)$$

Where: INFLAVE represents average inflation, OPEN refers to trade openness which is measured as the sum of export and import as a percentage of gross domestic product. To guard against under fitting the model, a set of control variables X_t including; the annual change in the Leone-US dollar exchange rate (EXCGGR), growth rate of gross domestic product (GDPGR), annual change in money supply broadly defined (MSGR), real interest rate (RIR) and domestic credit to private sector as a percentage of GDP (DCP) were also included in the model. An expanded form of the model in equation (1) is presented as:

$$\boldsymbol{INFLAVE_t = \beta_0 + \beta_1 OPEN_t + \beta_2 EXCGGR_t + \beta_3 GDPGR_t + \beta_4 MSGR_t + \beta_5 RIR_t + \beta_6 DCP_t + \varepsilon_t} \quad (2)$$

t = 1, 2, 3 ….T

$\beta_1 - \beta_6$: Parameters

β_0: Intercept

ε_t: Error term

A priori expectation: $\beta_1 < 0, \beta_2 > 0, \beta_3 > 0, \beta_4 > 0, \beta_5 < 0, \beta_6 > 0$

3.2 Estimation Technique

The estimation strategy begins with the examination of the stationarity properties of the variables in equation (2) using the Augmented Dickey Fuller (1979) test. This is warranted to ensure that none of the variables is integrated of order two I(2), as an inclusion of an I(2) variable in the ARDL specification would render the calculated F-statistics unreliable (Ouattara, 2004).

To establish the dynamic causal relationship between inflation and trade openness in Sierra Leone, the Autoregressive Distributed Lag (ARDL) modeling technique developed by Pesaran et al. (2001) is applied. This approach is very much appropriate in a circumstance where there is a combination of I (0) and I(1) variables in the model , contrary to the Eagle and Granger (1987) residual based and Johansen (1988) and Johansen and Jesulius (1990) system of equations based approaches that requires all the variables to be integrated of the same order I(1). In addition, the ARDL approach has advantages that makes it more appealing. These are: (i) the bounds test allows the relationships to be estimated by OLS once the lag order of the model is identified; (ii) it overcomes possible endogeneity problem in the model; (iii) it can estimate both short-run and long-run parameters of the model simultaneously; and (iv) this approach is relatively more efficient in the case of small and finite sample data sizes and the ARDL method can tolerate different lags in different variables.

To estimate the long and short-run relationship between inflation and trade openness, the study start by defining the unrestricted error correction model (UECM) as follows:

$$\Delta INFLAVE_t = \beta_0 + \sum_{i=1}^{p} \pi_1 \Delta INFLAVE_{t-i} + \sum_{i=0}^{p} \pi_2 \Delta OPEN_{t-i} + \sum_{i=0}^{p} \pi_3 \Delta EXCGGR_{t-i} + \sum_{i=0}^{p} \pi_4 \Delta GDPGR_{t-i} + \sum_{i=0}^{p} \pi_5 \Delta MSGR_{t-i} + \sum_{i=0}^{p} \pi_6 \Delta RIR_{t-i} + \sum_{i=0}^{p} \pi_7 \Delta DCP_{t-i} + \beta_1 INFLAVE_{t-1} + \beta_2 OPEN_{t-1} + \beta_3 EXCGGR_{t-1} + \beta_4 GDPGR_{t-1} + \beta_5 MSGR_{t-1} + \beta_6 RIR_{t-1} + \beta_7 DCP_{t-1} + \varepsilon_t \quad (3)$$

From equation (3) above, Δ represents the first difference operator,ε_t is the error term that is white noise, β_0 is the drift parameter and the lag length is expressed as p. The parameters $\beta_1 - \beta_7$ function as the long-run multipliers, while the parameters $\pi_1 - \pi_7$ are the short-run dynamic coefficients in the inflation- openness nexus relationship.

After the preliminaries, the first major step in the ARDL bounds testing approach is to estimate equation (3) by ordinary least square (OLS) in order identify the existence of long-run relationship among the variables using the following hypotheses:

H_0: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = 0$ (No Cointegration)

H_1: $\beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq \beta_7 \neq 0$ (Cointegration exist)

Decision on the above hypothesis is judged by a joint significant F statistic (Wald test). The null hypothesis is rejected if value of the F value is greater than the upper limit of the critical value, suggesting that there is a long-run cointegration relationship between the variables. If the F statistic is less than the upper limit of the critical value, the null hypothesis is not rejected, implying that there is no long-run cointegration relationship between the variables; When the F statistic is between the upper limit and the lower limit of the critical value the result is inconclusive, meaning it is impossible to judge whether there is a cointegration relationship between the variables.

Once it is confirmed that there is a cointegrating relationship among the variables, the short-run and long-run dynamics are estimated by the ARDL model in Equation (3). The long-run model is formulated as follows:

$$INFLAVE_t = \beta_0 + \beta_1 INFLAVE_{t-1} + \beta_2 OPEN_{t-1} + \beta_3 EXCGGR_{t-1} + \beta_4 GDPGR_{t-1} + \beta_5 MSGR_{t-1} + \beta_6 RIR_{t-1} + \beta_7 DCP_{t-1} + \varepsilon_t \quad (4)$$

The third and final step in the ARDL bounds test approach is to estimate an Error Correction Model (ECM) to capture the short-run dynamics of the system. The ARDL specification for the short-run dynamics is obtained from formulating an error correction model in the following form:

$$\Delta INFLAVE_t = \pi_0 + \sum_{i=1}^{p} \pi_1 \Delta INFLAVE_{t-i} + \sum_{i=0}^{p} \pi_2 \Delta OPEN_{t-i} + \sum_{i=0}^{p} \pi_3 \Delta EXCGGR_{t-i} + \sum_{i=0}^{p} \pi_4 \Delta GDPGR_{t-i} + \sum_{i=0}^{p} \pi_5 \Delta MSGR_{t-i} + \sum_{i=0}^{p} \pi_6 \Delta RIR_{t-i} + \sum_{i=0}^{p} \pi_7 \Delta DCP_{t-i} + \gamma ECM_{t-i} + \varepsilon_t \quad (5)$$

Where ε_i is the error term and γ is the coefficient of the error correction term which captures the speed of adjustment necessary to restore equilibrium in the dynamic model given a shock to the system in the previous period. The ECM coefficient should be statistically significant with a negative sign.

Finally, several diagnostic tests were conducted to ensure that the model parameters are reliable and can be used for policy analysis. To this end, the residuals were diagnosed to confirm whether they are serially uncorrelated, normally distributed and homoscedastic. The model was also subjected to specification test, using the Ramsey's RESET test and finally, the stability of the estimated parameters

were tested using CUSUM and CUSUMSQ tests.

3.3 Data

The empirical analysis in this study is based on annual time series data covering the period of 1980-2020. Data on openness (OPEN), growth rate of Gross Domestic Product (GDPGR), growth rate in nominal exchange rate (EXCGGR), annual growth rate in money supply (MSGR), real interest rate (RIR) and domestic credit to private sector as a percentage of gross domestic product (DCP) are sourced from the World Development Indicator (2020) database published by the World Bank and average Inflation (INFLAVE) in percentage change of Consumer Price Index (CPI) is collected from World Economic Outlook (2021) database published by the International Monetary Fund (IMF). The Eviews10 software program was used for data analysis.

4. Empirical Results and Discussions

4.1 Descriptive Statistics

Prior to estimating the model, the stochastic properties of the variables were examined and the result is presented in Table 1. It shows that on average, inflation, annual growth in nominal exchange rate and annual growth in broad money supply were very high during the sample period. It can also be observed that most of the variables exhibit high volatility as indicated by their respective standard deviations. Average inflation, annual change in nominal exchange rate and annual growth rate in broad money supply exhibited the highest variability over the period, while growth rate of GDP and domestic credit to private sector are the least volatile. The Jarque-Bera statistic suggests a mixture of normal and non-normal variables in study.

Table1. Descriptive Statistics

	INFLAVE	OPEN	EXCGGR	GDPGR	MSGR	RIR	DCP
Mean	31.10	37.71	30.72	2.48	32.06	1.20	4.53
Median	16.03	32.89	13.55	3.45	26.54	6.06	4.08
Maximum	178.70	75.14	215.89	26.42	88.40	27.15	8.22
Minimum	-0.92	12.94	-5.07	-20.60	2.62	-51.62	1.60
Std. Dev.	36.90	15.44	46.70	8.34	21.53	17.95	1.89
Skewness	2.11	0.68	2.28	-0.16	1.07	-1.06	0.44
Kurtosis	7.81	2.96	8.14	5.33	3.20	3.56	2.01
Jarque-Bera	69.91	3.19	80.50	9.43	7.95	8.15	2.99
Probability	0.00	0.20	0.00	0.01	0.02	0.02	0.22

Source: author's computation using Eviews 10

4.2 Correlation

The matrix of correlation coefficients for variables is given in Table 2. Accordingly, annual changes in nominal exchange rate and broad money supply are positively correlated to inflation while trade openness, growth rate of GDP, real interest rate and domestic credit to private sector are negatively associated with inflation. It is also shown that the correlation coefficients between the independent variables are relatively low, thus eliminating any possibility of collinearity between these variables.

Table 2. Correlation Matrix

	INFLAVE	**OPEN**	**EXCGGR**	**GDPGR**	**MSGR**	**RIR**	**DCP**
INFLAVE	1.00	-0.06	0.79	-0.17	0.69	-0.79	-0.21
OPEN	-0.06	1.00	0.07	0.28	-0.09	0.07	0.56
EXCGGR	0.79	0.07	1.00	-0.15	0.74	-0.67	-0.13
GDPGR	-0.17	0.28	-0.15	1.00	-0.15	0.34	0.11
MSGR	0.69	-0.09	0.74	-0.15	1.00	-0.68	-0.13
RIR	-0.79	0.07	-0.67	0.34	-0.68	1.00	0.23
DCP	-0.21	0.56	-0.13	0.11	-0.13	0.23	1.00

Source: author's computation using Eviews 10

4.2 Stationarity Test

The results of the ADF tests are reported in Table3 and indicate that the variables used in this study are a combination of stationary variables, I(0), and non-stationary variables, I(1). The variables that are stationary in level were: EXCGGR, GDPGR, MSGR and RIR. The other variables were non-stationary in level, but stationary in first difference.

They were: INFLAVE, OPEN and DCP. Since none of the variables is I(2), we can conveniently proceed to test for the long-run association between inflation and trade openness using the ARDL bounds test approach.

Table 3. ADF Unit Root Test Results

Variables	**ADF test**		**Conclusion**
	Levels	**First Difference**	
INFLAVE	-2.8370	-5.6140***	I(1)
OPEN	-2.8488	-5.6606***	I(1)
EXCGGR	-4.6027***	-	I(0)
GDPGR	-5.9156***	-	I(0)
MSGR	-3.8099**	-	I(0)
RIR	-4.9493***	-	I(0)
DCP	-2.4763	-6.7630***	I(1)

Source: author's computation using Eviews 10

4.3 Determination of Optimal Lag Length

The lag length selection criteria result is show in Table 4. Most of the information criteria suggest an optimal lag of 2. Thus, in this study lag 2 was used as the optimal lag to estimate the model. In addition, at lag 2, the residuals of the model are homoscedastic, normal and not serially correlated.

Table 4. Optimal Lag Length

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1048.768	NA	7.70e+14	54.14197	54.44056	54.24910
1	-930.4382	188.1148	2.29e+13	50.58657	52.97528*	51.44362
2	-866.3816	78.83880*	1.36e+13*	49.81444*	54.29326	51.42141*

Note. * indicates lag order selected by the criterion. *LR: sequential modified, FPE: Final prediction error, AIC: Akaike information criterion, SC: Schwarz information criterion, HQ: Hannan-Quinn information criterion.*

4.4 Test for Cointegration

The result of the bounds test is presented in Table 5 below. Since the computed F-statistics of 24.24 is greater that the upper bound (F > Upper Bound Value) at 1 percent level of significant, we can reject the null hypothesis of no long-run relationship between inflation, openness and the control variables. This implies the existence of a long-run cointegrating relationship among the variables of interest, hence the study proceeded to estimate the long-run and the short-run dynamic relationships.

Table 5. ARDL Bounds Test

F-Bounds Test		Null Hypothesis: No levels relationship			Conclusion
Test Statistic	Value	Significance	I(0)	I(1)	
F-Statistic	24.237	10%	2.12	3.23	
K	6	5%	2.45	3.61	Evidence of Cointegration
		2.5%	2.75	3.99	
		1%	3.15	4.43	

Source: author's computation using Eviews 10

4.5 Long-Run Analysis

Table 6 shows the results of the estimated long-run relationship between inflation, openness and the control variables in the model using the ARDL approach. The result shows that there exist a negative and statistically significant relationship between inflation and trade openness in Sierra Leone. Thus, a validation of Romer's proposition regarding inflation and trade openness association in the long-run in Sierra Leone. The results suggest that a 1 percent increase in trade openness will slow down inflation

by 0.69 percent. This finding is in line with other empirical studies (see Wynne & Kersting, 2007; Badinger, 2009; Kim et al., 2012; Jedidia et al., 2019 etc.).

Annual growth rate of the nominal exchange rate between the Leone and the US dollars has a positive and significant impact on inflation. The result suggests that a 1 percent depreciation of the Leone against the US dollars would lead to 0.86 percent increase in domestic prices. This result is in line with the theoretical debate that a depreciation of the exchange rate would exert pressure on prices in an import dependent small open economy like Sierra Leone. The result also corroborates the findings of other empirical studies (see Mukhtar, 2010; Bangura et al., 2013; Jedidia et al., 2019). The coefficient of real GDP carries a positive sign and is statistically significant at 5 percent level of significance and shows that a 1 percent increase in real GDP brings about 1.027 percent increase in inflation rate. This finding is in line with Menghan (2008) who also found a positive long-run relationship between real GDP and inflation. The result also shows a positive and significant impact of domestic credit to private sector as a percentage of gross domestic product on inflation. This means that a 1 percent increase in domestic credit to private sector would result in an increase in prices by 5.48 percent. The result for the other explanatory variables suggest that annual growth in money supply and real interest rate do not significantly impact inflation in the long-run in Sierra Leone.

Table 6. Long-run Estimation Results

Dependent variable is INFLAVE

Variable	Coefficient	Std. Error	t-Statistic	Prob.
OPEN	-0.691	0.182	-3.797	0.001
EXCGGR	0.869	0.120	7.216	0.000
GDPGR	1.027	0.411	2.501	0.019
MSGR	-0.200	0.166	-1.208	0.238
RIR	-0.421	0.261	-1.612	0.120
DCP	5.484	1.517	3.615	0.001

Source: author's computation using Eviews10

4.6 Short-Run Analysis

Table 7 presents the estimates of the short-run model from the variables under study. All the coefficients of the variables maintain their signs as in the long-run equation except the coefficient of domestic credit to private sector whose sign changed from positive to negative. In addition, all the variables in the short-run model are statistically significant except real interest rate, indicating that real interest rate does not impact price dynamics in Sierra Leone. On the relationship between inflation and trade openness, the result suggest that trade openness also have a disinflationary impact on the Sierra Leone economy in short-run. It particularly indicate that a 1 percent increase in openness would reduce

inflation by 1.32 percent. The lag value of inflation was found to be statistically significant but with a negative sign, indicating an inverse relationship with current inflation in Sierra Leone. This result is consistent with previous inflation study on Sierra Leone which shows less inflation persistence (see Kovanen, 2006). Among the control variables, nominal exchange rate was found to be statistically significant and contributes positively to inflation. The result indicates that a 1 percent depreciation in the exchange rate leads to a 0.51 percent increase in prices. This outcome is in line with other empirical studies on Sierra Leone (see Bangura et al., 2013; and Gottschalk et al., 2008). Also, GDP growth rate maintained it positive coefficient and is statistically significant in influencing inflation. With a coefficient of 0.38, it indicates that a 1 percent increase in GDP growth rate is matched by 0.38 percent increase in inflation. Unlike the long-run, domestic credit to private sector showed a significant negative impact on inflation. This implies that domestic credit to private sector has a disinflationary effect on the Sierra Leone economy in the short-run. In specific terms, a 1 percent increase in credit to the private sector would lead to 4.80 percent reduction in inflation.

The coefficient of the error correction term (ECT) was negative and statistically significant as expected, providing further evidence that the variables are cointegrated. The error correction term indicates that deviations from the long-run equilibrium in inflation in the previous year is corrected by 99 percent the following year.

Table 7. Short-run Estimation Model

Dependent variable is INFLAVE

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.351	1.583	5.908	0.000
D(INFLAVE(-1))	-0.212	0.051	-4.150	0.000
D(OPEN)	-1.321	0.191	-6.930	0.000
D(EXCGGR)	0.513	0.047	10.955	0.000
D(GDPGR)	0.375	0.158	2.374	0.026
D(RIR)	-0.073	0.108	-0.679	0.503
D(DCP)	-4.797	1.526	-3.144	0.004
CointEq(-1)	-0.991	0.068	-14.504	0.000

Source: author's computation using Eviews 10

4.7 Diagnostic Test

The results of the diagnostic tests are presented in Table 8. It can be concluded that the model provides a reasonably good fit and is robust as it does not suffer from serial correction, heteroscedasticity, misspecification and normality issues.

Table 8. Diagnostic Test Results

Type of test	Test-Stat	P-value
Heteroscedasticity	1.38	0.24
Serial correlation LM test	0.51	0.61
Ramsey RESET test	2.48	0.13
Jarque-Bera test on normality	0.46	0.79

Source: Author's computation using Eviews 10

4.8 Stability of the Estimated ARDL

Stability of the model parameters were tested using Cumulative sum (CUSUM) and cumulative sum squares (CUSUMSQ) tests. They tests suggest stability of the parameters of the estimated model, as their plots lie within 5% level of significance (**see Figures 2 and 3**). Thus, the model can be used for policy prescription.

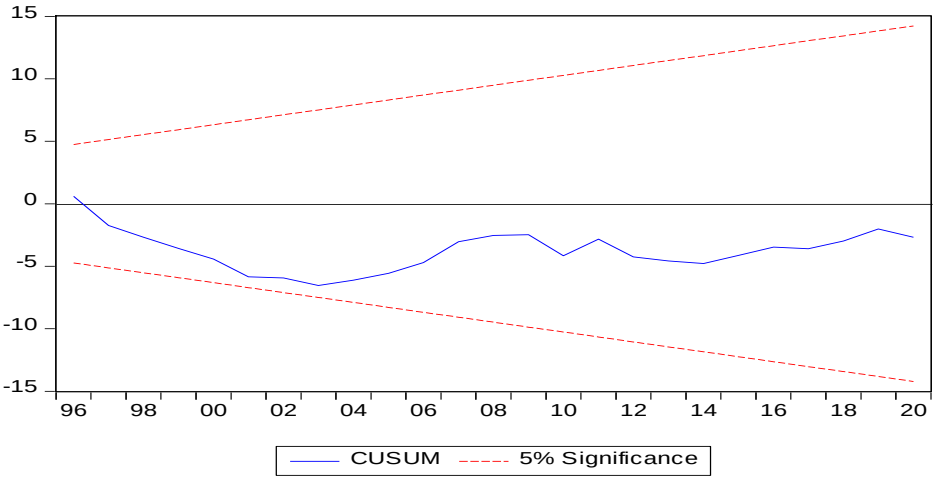

Figure 2. CUSUM Stability

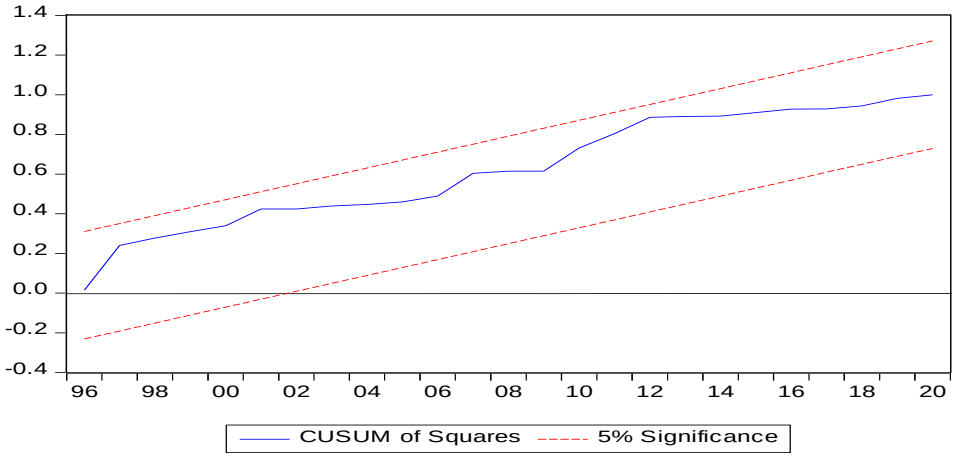

Figure 3. CUSUM of Squares Stability

5. Conclusion

This study is the first attempt at validating the Romer hypothesis which posits that inflation tends to slowdown when trade openness increase. To ensure that the estimated model is well specified, control variables like exchange rate, gross domestic product, money supply, real interest rate and credit to private sector were also included in the model. To achieve the set objective, the study utilized the ARDL cointegration and Error Correction Method using data for the period 1980-2020. In addition, a battery of diagnostic tests were conducted to confirm the robustness of the model. The key findings from the study is that the Romer hypothesis holds for Sierra Leone in both the long-run and the short-run, indicating that trade openness tends to ease inflationary pressures. The policy implication from this outcome is that reform agenda should encourage a more open and liberalized trade regime which could support the price stability objective of the monetary authority.

The control variables, exchange rate and gross domestic product were found to have a positive and significant impact on inflation in both the short-run and long-run, whereas domestic credit to the private sector impacts inflation positively in the long-run but have a disinflationary impact in the short-run. Finally, money supply and real interest rate were found to have no effects on inflation in both the short-run and long-run.

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