International Commodity Prices and Inflation Dynamics in Sierra Leone

Jonathan D. Danladi

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International Commodity Prices and Inflation Dynamics in Sierra Leone

By

Jonathan D. Danladi
Department of Economics,
Afe Babalola University Ado-Ekiti,
Nigeria

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Abstract

This study examines the impact of international commodity price changes, measured in local currency, on consumer prices in Sierra Leone. Monthly data from January 2007 to August 2016 are used to examine the long-run relationship and the short-run dynamics. The study finds the dynamics of cocoa, oil and rice prices as significant determinants of domestic consumer prices both in the long-run and the short-run. Domestic consumer prices are shown to respond negatively to rising cocoa prices, one of the country's major export commodities. The study suggests deliberate efforts on the part of authorities for the improvement and expansion of production base of the country's export commodities such as cocoa and rice, which the country has comparative advantage, to reduce the pressure on the local currency and the prevalent upward trend of consumer prices. A diversified energy source and an active production sector can reduce the overdependence on oil and, ultimately, the direct pass-through of commodity price fluctuations to consumer prices in the economy.

Key words: commodity prices, inflation, cocoa, rice, oil

1. Introduction

Inflation in most developing countries is driven significantly by commodity prices, majorly food and energy prices in the international market. Fluctuations in international commodity prices have affected several developing and low-income countries, cumulating into effects such as general high price levels and unstable macroeconomic environments (Durevall et al, 2013). IMF (2008) pointed out that increasing domestic food prices, which are reflections of the twin sharp increases in world commodity prices and some local supply disruptions, have been widely viewed as key elements driving inflation. Habermeier et al (2009) posit that the main causes of increase in inflation were demand pressures and commodity prices, and that the initial impact of commodity price increases was followed by second-round effects. In many small open economies, commodity prices play significant roles in shaping their inflationary dynamics and persistence (Desormeaux et al, 2009). Over the years, there have been rising concerns in Sierra Leone with respect to the responses of consumer prices to fluctuations in international commodity prices as they affect macroeconomic predictability and the value of the Leone. The economy is heavily commodity import-dependent, as rice and fuel constitute more than 60% of total imports. It also depends on exports of primary commodities for foreign exchange and sustainability. Thus, what is the impact of international commodity prices on domestic consumer prices in Sierra Leone? The study makes effort to answer this question by estimating a model of inflation for Sierra Leone. This is done given the relative paucity of evidence with resect to an empirical study that attempts to examine the relationship between commodity prices and inflation dynamics for the country.

Commodity prices have been identified as leading drivers and indicators of inflation as they translate to higher consumer prices through two basic channels: the demand and supply channels. On the demand side, inflation responds more quickly to general economic shocks such as an increase in demand. On the supply side, changes in commodity prices reflect idiosyncratic shocks that invariably decimate the supply of certain agricultural products, which are subsequently passed through to overall prices.

Of direct concern is the inevitable distortion and shift from the moderate or steady state inflation rate as this often leads to complications for monetary authorities. Despite the recent slump in the global oil price, domestic food prices remain unbearably high in Sierra Leone and consumer prices have been on the rise. These upswings and downswings in the consumer price level are traceable to persistent devaluation of

the currency, domestic vulnerabilities, dependence on extractive resources, and non-realization of the benefits of intra-trading to boycott the intervention of the dollar (Mansaray et al, 2015).

Fluctuations in global food prices are due to a number of cluttered factors such as droughts in key grain-producing regions, low stocks for cereals and oilseeds, increased feedstock use in the production of biofuels, rapidly rising oil prices and a continuing devaluation of the US dollar, the currency in which indicator prices for these commodities are typically quoted. This turmoil in commodity markets has occurred against the backdrop of an unsettled global economy, which in turn appears to have contributed to a substantial increase in speculative interest in agricultural futures markets (OECD, 2008).

The impact of high food prices on developing countries depends on the interplay of various factors. In general, commercial producers of these commodities will benefit directly from higher prices, as will in many cases the people they employ (assuming, of course, that governments do not prevent higher prices on world markets from being transmitted to domestic markets). For farm households producing mainly for their own consumption or for local markets insulated from price fluctuations on national and international markets, the impacts will be mitigated. However, for the urban poor and the major food importing developing countries, the impacts will be strongly negative as an even higher share of their limited income will be required for food. This is the case with the Sierra Leonean economy. Each 10% increase in the prices of all cereals (including rice) adds nearly US$ 4.5 billion to the aggregate cereals import bill of those developing countries that are net importers of cereals (OECD, 2008).

The size of the Sierra Leonean economy by GDP is US$ 3.76 billion as at 2017. The economy is relatively small in comparison to its other West African counterparts. It is the fourth smallest economy in terms of GDP among the 15 West African countries. Only Liberia (US$ 2.27 billion), Cape Verde (US$ 1.64 billion) and Guinea Bissau (US$ 1.17 billion) are smaller. The Sierra Leonean economy is an open economy with 38.77% degree of openness using the ratio of the sum of export and import to GDP measure of openness (World Bank, 2017). The country's economy is mainly driven by primary commodities mainly agriculture and mineral production. These primary commodities are subject to the effects of significant fluctuations in commodity prices. In Sierra Leone, as in most economies, of direct concern to the monetary authorities is the upward shift of consumer prices from the moderate or steady state prices. Global prices are expected to be key determinants of domestic inflation and working primarily through the trade channel as the economy is highly integrated with the global value chains. It is also noteworthy to express that persistent high oil prices adversely affect net importers of oil such as Sierra Leone. Notwithstanding the recent slump in the global oil price starting from June 2014, food prices remain high in Sierra Leone and consumer prices have been on the rise. These swings in consumer prices are traceable to domestic vulnerabilities, dependence on extractive resources, and non-realization of the benefits of intra-trading.

For a net food importing country, food prices continue to increase with the degree of price increases varying across the regions of the country. Sierra Leone is also a food

importing economy as it imports food to augment food deficit from low agricultural and industrial activities and experiences unfavourable political and ecological environment. Food prices are the highest in rural areas compared to other areas of the country. This implies that external developments relating to the global food crisis will hit hardest the poor in the country, who mainly reside in rural areas. Rising food price threatens the affordability of food to vulnerable segments of the population, particularly those who benefit from social safety net programmes that offer cash transfers. It has been argued that increased speculation in commodity markets is provoking increased activity in these markets. It is also useful to note that both the demand for and the supply of oil react sluggishly to changes in prices in the short-run, therefore, very large changes in prices can be required to restore equilibrium if demand should move even modestly out of line with supply.

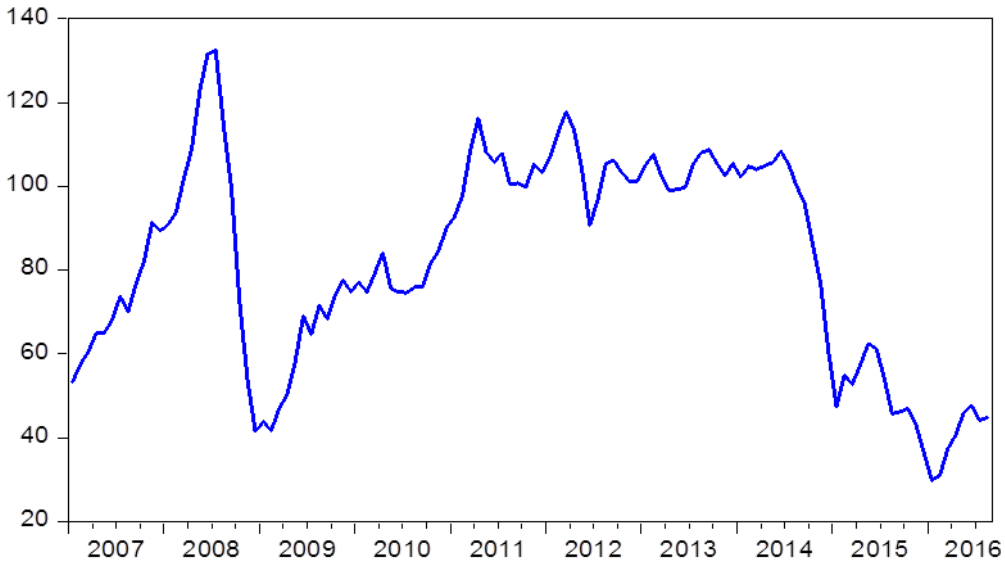
To this end, this study examines the relationship between commodity prices and inflation dynamics for the country. This is done using monthly data for the period January 2007 to August 2016. The study uses the general-to-specific modeling technique and estimates a single-equation error correction model (ECM). The domestic Consumer Price Index (CPI) model was estimated using rice and cocoa prices as the major food components and crude oil prices as the major non-food component. All prices are denominated in the local currency.

The remainder of the study is organized as follows: section 2 presents some stylized facts about the Sierra Leonean economy. Section 3 presents a review of related literature. Section 4 provides the methodology for the study. Section 5 presents empirical results and analysis. Section 6 draws the study's conclusion and policy suggestions.

2. Stylized facts

The relationship between commodity prices and inflation dynamics is often seen in the light of a cause and effect type of relationship. For an importing country, as commodity prices move up or down, inflation follows in the same direction. Oil, as a case, is a major input in most developing economies. It is used in critical activities such as fuelling transportation, industrial activities, heating homes, etc. Therefore, if input costs rise, so will the cost of end products and thus inflationary trends. An analysis of international prices of crude oil, cocoa and rice reveal varying trends.

Figure 1: International crude oil prices in US$ (January 2007- August 2016)



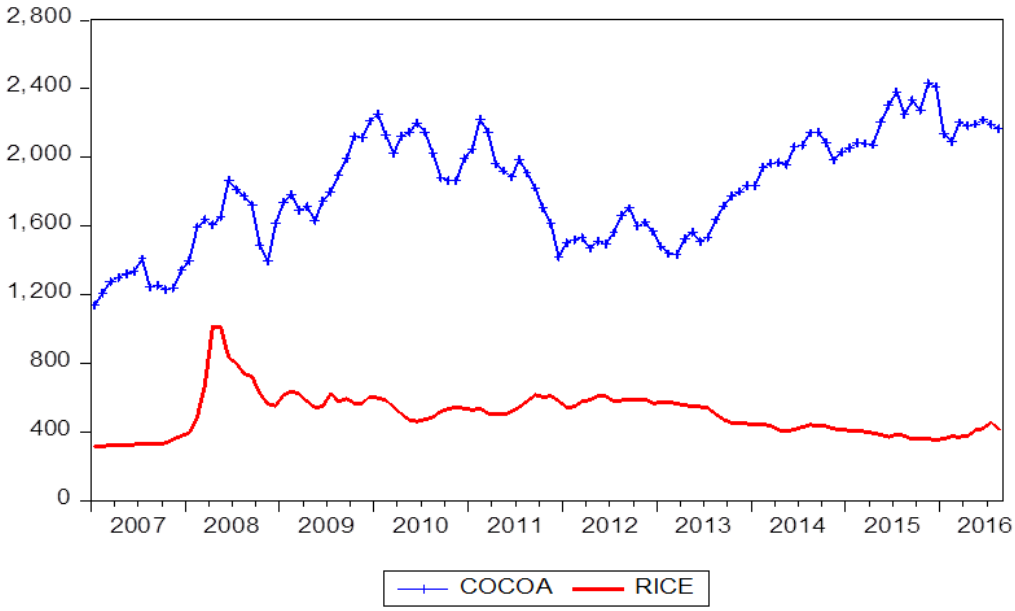
Source: UNCTAD

From January 2007 to July 2008, oil prices grew at an average rate of 148.1%. However, the prices slumped from a peak of US$ 133pb in July 2008 to a bottom low of US$ 41pb in February 2009, representing about 70% decline in the global price of crude oil. OPEC attributed this to the economic mismanagement of the United States and the rebuff to boost output. Since then, oil prices have been on a sustained high before 2014. However, between January 2014 and December 2015, oil price dropped from US$ 102.25pb to US$ 36.56pb, representing a 64.7% decline. Primarily, fluctuations

in world oil prices have been due to the contraction and expansion of oil production volume vis a vis the consumption. In explicit terms, the oil market had always been sensitive to short-term supply changes and the actions and intentions of OPEC in addition to the discovery of shale oil in USA - one of the largest consumers of crude oil.

Figure 2 shows the international prices of cocoa and rice. The prices of these commodities have witnessed periods of short-run swings. The prices exhibited varying degrees of fluctuations from month to month.

Figure 2: International prices of rice and cocoa in US$ (January 2007- August 2016)



Source: UNCTAD

The price of rice was steady for a large part of 2007. However, it witnessed a sharp rise in 2008, which coincided with the global financial crisis era, representing about 168.6% in April 2008 from its December 2007 value. From its peak period in 2008, the price fell sharply in the late 2008 but remained slightly higher than its 2007 values. The fluctuation in the price of rice had remained largely minimal up until August 2016, the end period of the study. The price of cocoa witnessed a far greater instability in relation to the price of rice over the period under consideration. A steady rise is observed from 2007 up until 2012. The prices remained low between 2012 and 2013. However, they picked up again in 2013 and since then they have remained high.

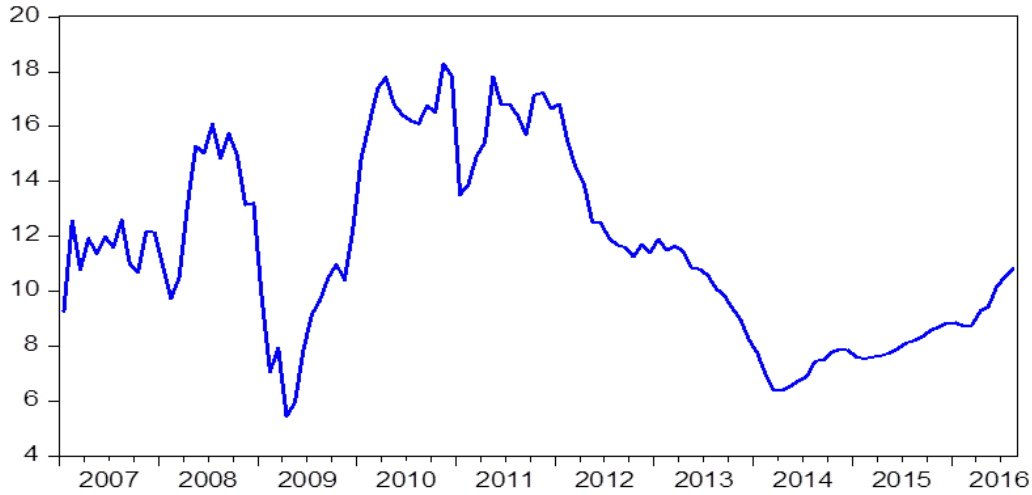
Inflation dynamics, which are the episodes of high and low inflation, are a function of prices of both exported and imported commodity prices ceteris paribus. Changes in domestic food prices are stimulated by changes in oil prices given the vital role oil plays in the provision of energy needed to power factory machines and for transportation. This largely suggests that whatever direction the global crude oil price swings to, the

global and domestic prices of food items are expected to move in the same direction, given its impact through the production costs channel.

Sierra Leone has a rich natural resource base, with the major occupation being agriculture and mining. Mining and exports of diamond, iron ore and bauxite, among others, constitute about 79.2% of the country's total export earnings as at 2017. Agriculture contributes about 60.1% to the country's GDP. It is the largest employer of labour in the economy, with rice as the major staple crop of the country (World Bank, 2017). It is a country that depends largely on refined oil as a major source of energy, which it imports from other countries. The major food import commodity in Sierra Leone is rice. The country's key exports commodities are cocoa and iron ore. The country has largely been affected by a long and devastating civil war, which lasted for more than a decade (1991-2002). The result on the economy included, but not limited to, slow growth, weak social and economic institutions, and widespread poverty in relation to its other West African counterparts. The normalization of economic conditions was largely facilitated following the signing of a peace accord in July 1999 in Lome. Cessation of hostilities was followed by concerted efforts to resettle displaced people. This has largely put the economy on the pathway of recovery, and confidence in the economy has been reinforced, which has enhanced macroeconomic stability overall in the post-war era. Small-scale enterprises and individual sellers dominate retail markets in the country. They offer mainly primary goods for sale. The prices of food items, by their very nature, are typically more volatile than the prices of non-food items. This in part explains the relatively high frequency of price changes in the retail sector (Kovanen, 2006).

Following the post-war period and the election of Sierra Leone's incumbent president in 2007, the country enjoyed a period of stable and lower inflation. However, being a small open economy like most other countries, it was adversely affected by the global economic and financial crises of 2008, thereby driving prices upwards. The rising price trend was quickly reversed following the end of the global recession leading to a declining trend in inflation down to the lowest point in 2009 before another round of upward trend started, occasioned by the depreciation of the Leone (Figure 3). As noted earlier, Sierra Leone depends heavily on primary exports for foreign exchange receipts and on imports for consumption and production of most goods. The demand for foreign exchange in Sierra Leone increased mainly as a result of rising level of imports, which increased due to expanding economic activities at home; foreign banks and institutions recalling existing loan facilities in the wake of global credit crunch; declining remittances from abroad in the wake of the credit crunch; and finally demand by speculators who believe that the exchange rate may depreciate further in future given the developments in the global arena. These factors asserted sufficient pressure on the Leone, leading to its depreciation[1].

Figure 3: Trend of monthly inflation (January, 2007 – August, 2016)

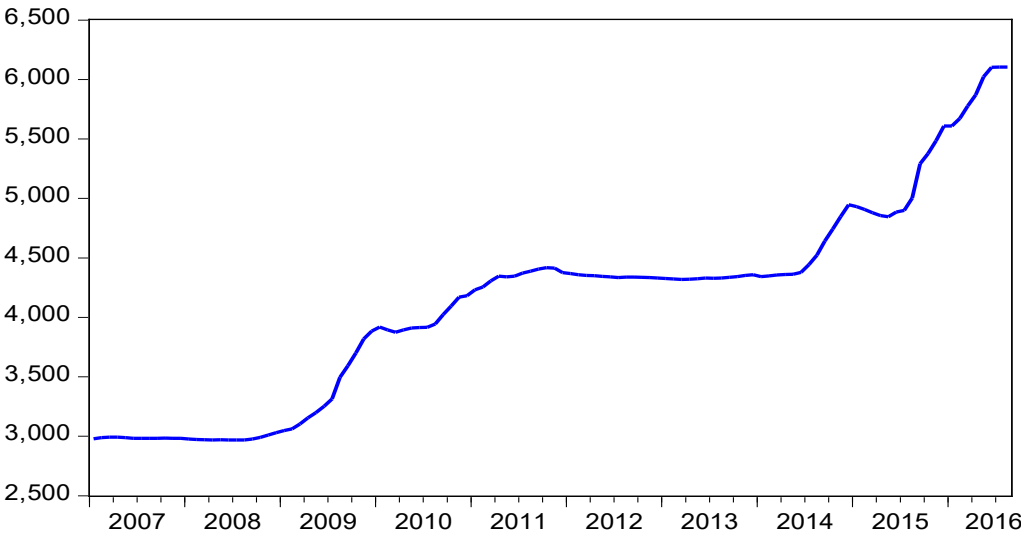


Source: Bank of Sierra Leone

Additionally, exporters earn more in local currency and imports are reduced with lower value of the currency. A depreciation of the exchange rate raises the domestic price of imported goods, which in turn should discourage Sierra Leoneans from consuming these imported products. Given these dynamics, a depreciation of the Leone against the US dollar should improve the country's current account deficit and possibly the overall balance of payment. However, given that Sierra Leone is heavily dependent on imports, a depreciation of the exchange rate will not reduce the volume of imports into the country.

The correlation between inflation and the rate of nominal exchange rate depreciation can indeed be high in an unstable monetary environment in which nominal shocks fuel both exchange rate depreciation and high inflation. Therefore, in the late 2009, the Leone depreciated over 30% against the US dollar. The decline in the value of the Leone within that period led to higher prices. A lower value of the Leone resulting in rising cost of imports, which in turn fed into higher consumer prices since imports, especially of food and energy constitute a major proportion of consumer price index basket[2]. The effect of this is a reduction in the welfare of people as the same amount of income was only able to buy fewer goods and services than before. This shows that controlling the exchange rate depreciation is a strategic monetary policy that supports poverty reduction. In an economy where virtually every price is, in one way or the other, quoted in foreign currency terms, depreciation is inflationary. Overall, one thing that is very clear from all this is that the depreciation of the Leone has negative impact on inflation and therefore on the welfare of the people. The rising price trend continued until late 2012 when the Central Bank intervened in the foreign exchange market and supported the Leone.

Figure 4: Trend of Leone/US$ monthly official exchange rate (January, 2007 – August, 2016)



Source: Bank of Sierra Leone

The economy achieved commendable economic growth rates in the post-war period with the launching of the government's Agenda for Prosperity (A4P), 2013-2018, following the peak period in the rise of consumer price between 2010 and 2013. Additionally, being a fuel import-dependent economy, the crash in the price of crude oil in the international market to less than US$40 per barrel from more than US$100 per barrel further boosted the economy and reduced inflationary pressures associated, hitherto, with importation of the commodity at higher cost within the period. The continued double-digit growth was propelled by resumption in iron ore production combined with government's investment in infrastructure, and buoyant activities in agriculture, tourism and services. This stabilized the market in the short term, and then reversed the declining trend in the medium term, leading to lower inflation which extended to 2014 before a fall in the price of iron ore. The fall in the price of iron ore affected macroeconomic and financial stability of the country. The hitherto remarkable and positive path to economic recovery rather took a reversed trajectory. According to Zayid et al (2015), Sierra Leone's economic growth declined from a buoyant 20.1% in 2013 to 4.6% in 2014, representing a significant 77.1% fall in economic growth. Further, the economy shrank by 21.5% in the year 2015. Following the sustained decline of iron ore prices, Sierra Leone has been on the path of recovery ever since. Although there is modest recovery of iron ore prices, the impact of the resumption of iron ore mining is yet to be buoyant due to the limited scale. The depreciation of the Leone between 2015 and 2016 by 20.4% significantly generated inflationary pressures, with consumer prices rising from 9.0% in 2015 to 10.84% in August 2016, which is above the target of 9.5% stipulated under the IMF supported Extended Credit Facility Programme.

3. Literature review

A major contribution of this paper is that for Sierra Leone, there is relative paucity of evidence regarding the determinants of inflation dynamics in the country. Particularly, there is a gap in the literature with respect to the impact of and the transmission of international commodity prices to domestic prices in the country, where both the impact of food and non-food commodities are empirically examined using monthly data covering the period that is very crucial to the economic recovery of the country (2007-2016) following a decade of civil war. Over the years, quite a number of studies have emerged on the determinants of inflation and the linkage between commodity prices and inflation rate. Gottschalk et al (2008) and Mansaray-Pearce and Pingfeng (2015) have attempted to examine the determinants of inflation in Sierra Leone. They found that domestic inflation increases as oil price and money supply rise and nominal exchange rate depreciates. In the short-run, money supply and GDP have a significant and positive impact on inflation rate, while interest rate has a negative but significant relationship. No significant relationship among exchange rate and import to inflation rate in the short-run was found. Their result further depicted that in the long run, money supply, GDP, interest rate and imports significantly have impact on inflation, while exchange rate, interest rate and imports have a negative impact.

Durevall et al (2013) found in their study on inflation dynamics and food prices in Ethiopia showed that movements in international food and goods prices determined the long-run evolution of domestic prices. In the short run, it was shown that agricultural supply shocks affected food inflation, while money supply growth affected short-run non-food price inflation. In a study conducted on economies of some sub-Saharan countries, Hilegebrial (2015) explored the determinants of food price inflation in Ethiopia using the OLS. The findings revealed that food price is significantly impacted by money supply and speculations, output and world food price factor.

According to Gelos and Ustyugova (2012), a price spike is likely to have more impact on countries with already high inflation levels and weak institutions. It is, to some extent, obvious that energy prices as traditionally determined by supply and demand volumes have a serious impact on domestic inflation. The pass-through is the value chain (production and distribution). Additionally, demographic changes and weather patterns have been observed to be part drivers of changes in food prices, which eventually generate changes in inflation. Also, prices of fertilizer and other agricultural and industrial inputs that are imported can cause changes in food prices.

Tangermann (2008) opined that 75% of price increase in 2008 was due to biofuels. Speculation was viewed as a major driving force behind price increase. Empirical evidence and observed trends show that rapidly growing food demand in the emerging economies is pushing up global food prices. Rising food prices generate both market and government panic. Speculation in the market may stimulate demand for stockpiling of goods, which will eventually raise the prices of food further to manage scarcity. Price control also contributes to food price inflation as sellers try to take advantage of the short-term stickiness of price and go into commodities hoarding, which may generate scarcity and hit back at the market through price hike. OECD (2008) analysis spelt out two factors militating against agriculture and food production; these are rapid increase in crude oil prices and energy prices, and the weak exchange rate driving up dollar-denominated commodity prices in international trade.

The contribution of biofuels production to the market in terms of raising the gap between use and output and pushing up global food prices can be attributed to demand from regions such as North America where maize and vegetables hardly grow and also the need to cut down on fossil fuel burning so as to combat climate change. In summary, several factors are behind increase in food prices but one of them is clearly a result of deliberate policy decisions, i.e. to support the expansion of biofuels production and use. This should reduce demand for the energy provision proportion of crude oil demand and further crude oil price. Also, it is noteworthy that Sierra Leone is also an agrarian economy besides its focus on other minerals.

Chuah et al (2015) examined the impact of global commodity prices on inflation dynamics in Malaysia. They found that the pass-through from global commodity prices to headline inflation is insignificant. The study discovered that commodity prices are particularly relevant to economies that are undergoing a transition period of subsidy rationalization. The relationship between global commodity prices and inflation dynamics was examined. Global commodity prices were found to have a positive pass-through to headline inflation in the 2000s, which makes global commodity prices relevant determinants of inflation. However, their result suggests that a shock to domestic fuel and food prices could have some impact on core inflation. Desormeaux et al (2009) examined commodity prices, terms of trade and inflation dynamics in Chile. Their findings suggest that an oil price shock generates a direct increase in CPI inflation, and an indirect effect through its impact on the marginal cost faced by domestic firms. Hobijn et al (2009) studied commodity price movements and inflation in the US economy. The study findings suggest that commodity price increases affect relatively few goods prices; higher crop prices translate narrowly into price hikes for food, tobacco, and gardening supplies; and rising oil prices mainly influence fuel, energy, and transportation prices. Unalmisy et al (2012), and Kilian (2009) using an estimated DSGE model for the US economy found that productivity shocks are the most important drivers of oil price fluctuations during 1982-2007, but the storage demand shock has played a role as well. The results suggest a change in the composition of shocks, which can help explain the resilience of macroeconomic environment to oil price hikes in 2000s. Speculative storage was found to have a

mitigating or amplifying role depending on the nature of the shock.

Other cross-country studies include Cecchetti et al and Moessner (2008), and Böwer, et al (2007). Cecchetti and Moessner (2008) examined the impact of the rising food and energy prices on headline inflation dynamics in some selected advanced and emerging economies. Their findings suggest that in recent years, core inflation showed no tendency of reverting to headline, which suggests that higher commodity prices have generally not spawned strong second-round effects on inflation. Böwer et al (2007) examined the impact of commodity price fluctuations on monetary and fiscal policies in Western and Central Africa. Their results suggest that inflation rates appear less affected by commodity price changes, although pass through effects from international to domestic energy prices were significant.

Joachim and Getaw (2012) looked into the causes and costs of global food price spikes and the dynamics cum complexities of price formation mechanisms. It was found that the marginal utility of income of households in developing countries that are net food sellers is negatively correlated with risk, thereby causing lower input use and production under risk than under certainty. Craigwell et al (2012) showed empirical evidence that prices take longer to change in developed countries than in developing economies. There is need to appraise the level of demand pressure on international commodities from the Caribbean citizens and other developing economies.

4. Methodology

Modeling inflation and commodity prices in Sierra Leone

The Phillips curve and the quantity theory of money have been identified as traditional approaches by which inflation is commonly modeled. Given that the Phillips curve largely postulates a supposedly inverse relationship between the level of unemployment and the rate of inflation, it may be inadequate in explaining inflationary trends in low income underdeveloped economies. This is due mainly to the large share of underemployment and informal markets, and the strong propensity for agricultural supply shocks to increase the growth of GDP and hence lower inflation in these economies. The quantity theory of money, which is widely applied by most studies on Sub-Saharan Africa, is based on the assumption that money demand and supply is the reason for inflation (Durevall et al 2013). The quantity theory of money would have been ideal in the analysis of the dynamics of inflation in Sierra Leone. However, the economy is highly dollarized and, as such, the Bank of Sierra Leone has limited control and influence over the country's monetary policy variables such as money supply and interest rates.

In Sierra Leone, following the adoption of the floating exchange rate in the early 1990s, an atmosphere was created in the economy in which most transactions are quoted in foreign currencies, particularly the US dollar, and foreign currency deposits at commercial banks have increased significantly. Since 2006, the currency substitution index has been above the 30% benchmark[3]. This suggests the existence of currency substitution problem in the country, the effect of which is instability of money demand function and a weakening of the effectiveness of monetary policy (Bathalomew and Kargbo, 2010).

In recent times, however, inflation is modeled as due partly to the impact of foreign prices and internationally traded goods (Durevall et al 2013; Blavy, 2004; Moriyama, 2008; Olubusoye and Oyaromade, 2008). This argument is valid for a small open economy such as Sierra Leone that depends on imports and exports of primary commodities for foreign exchange earnings and import demand of primary commodities for domestic use. Inflation responds more quickly to general economic shocks such as an increase in demand. Commodity prices are quick to respond more rapidly to economy-wide shocks to demand. Generally, they are set in highly competitive auction markets and consequently tend to be

more flexible than prices overall. Commodity price movements are expected to be positively related to changes in aggregate price inflation. The link between commodity prices and inflation increases to the extent that demand shocks are not sector-specific.

As noted earlier, changes in commodity prices reflect idiosyncratic shocks that invariably decimate the supply of certain agricultural products, which are subsequently passed through to overall prices. In the case of a direct shock to the supply of a commodity, movements in the price of the commodity could be positively related to overall prices. The extent of the effect will largely be dependent on the relative importance of the commodity being shocked and the flexibility of other prices. Cocoa, rice and petroleum products constitute a larger share of the country's export and import commodities. Commodities constitute a larger share of the country's food basket in general. Thus, commodity prices are leading drivers and indicators of consumer prices. Summarily, nominal prices in the small open economy are affected in the long-run by the balance of aggregate demand factors, on the one hand, and supply-side and pass-through effects of world prices on the other. Inflation is modeled as the deviation from these long-run anchors (Furlong and Ingenito, 1996; Adams and Simpasa, 2015).

From the foregoing discussion and with respect to the commodities with greater influence on consumer prices in the Sierra Leonean economy, a representative estimation equation is specified. The study considers two variants of consumer prices prevalent and collected differently in Sierra Leone as appears in official statistics from the Bank of Sierra Leone and the Ministry of Finance. These are the consumer price index national and the consumer price index Freetown. According to the Sierra Leone statistics authorities, the national CPI measures the change in prices, on average, from month to month, of the goods and services bought by most households in the major provinces and towns across the country as a whole including all expenditure groups and both families and single persons. The Freetown CPI measures the change in prices, on average, from month to month, of the goods and services bought by most households in the country's capital city, which is often considered as a significant representation of consumer prices in the country[4].

The choice of the models is based on the assumption that the variables are non-stationary and cointegrated. The equation below is the representative specification for model for the analysis.

$$\Delta CPI_t = \alpha_0 + \sum_{t=1}^{k-1} \alpha_{1i} \Delta CPI_{t-i} + \sum_{t=1}^{k-1} \alpha_{2i} \Delta COCOA_{t-i} + \sum_{t=1}^{k-1} \alpha_{3i} \Delta OIL_{t-i}$$
$$+ \sum_{t=1}^{k-1} \alpha_{4i} \Delta RICE_{t-i} + \alpha_5 (CPI_{t-i} - \text{ø}_1 COCOA_{t-i} - \text{ø}_2 OIL_{t-i} - \text{ø}_3 RICE_{t-i}) + u_t$$

All the variables are expressed in their log forms and Δ is the first difference operator where CPI is consumer price index COCOA, OIL and RICE are, respectively, the international prices of cocoa, crude oil and rice in local currency. The term in parenthesis

is the error correction term; it measures the speed of adjustment to equilibrium after a deviation with the ϕ_i as long-run coefficients while u is the error term.

Estimation techniques and data

The analysis starts by testing for unit roots of the variables. Typically, the unit root tests are conducted to investigate the time series stationarity properties of the variables before carrying out cointegration tests. The stationarity tests here are carried out using the Augmented Dickey-Fuller (ADF) test and the Phillips-Perron test[5]. Under the assumption that the variables are not stationary at level but their respective first differences, cointegration tests are conducted. The cointegration tests are done to determine whether the variables are cointegrated or not. If the variables in the equations are cointegrated, it implies that there is a long-run equilibrium relationship existing among the variables. This is to say that if a set of variables is cointegrated, the effects of a shock to one variable spread to the others, possibly with time lags, to preserve a long-run relationship between the variables. This is in line with the work of Engel and Granger (1987) which provides a theoretical approach to the concept of cointegration by postulating that even though the dependent variable and its determinant(s) may be individually non-stationary, they will tend to move together in the long-run, to the extent that a linear combination of them will be stationary. The existence of this long-run relationship is the basis for the short-run disequilibrium adjustment in the model generally known as error correction mechanism.

This study examines the relationship between the estimated variables using the cointegration and vector error correction technique. Monthly data series from January 2007 to August 2016 were employed to examine the relationship. Estimation on time series data demands that the series be stationary. The data sets on the commodity prices were obtained from the United Nations Conference on Trade and Development (UNCTAD). The series on CPI National and CPI Freetown were obtained from the Bank of Sierra Leone and the Sierra Leone Ministry of Finance. The consumer price indices were collected for 251 items. The National CPI was computed by aggregating the CPI for the index towns in the country. As stated earlier, it measures the change in prices, on average, from month to month, of the goods and services bought by most households in the major provinces and towns across the country as a whole while the Freetown CPI measures the change in prices, on average, from month to month, of the goods and services bought by most households in the country's capital city, Freetown.

5. Presentation and analysis of empirical results

Stationarity test

Stationarity test was conducted to test for unit roots of the variables used in the study using the Augmented Dickey-Fuller test and the Phillips-Perron test and the results are presented in Table 1. Note that the MacKinnon (1996) critical values for the Augmented Dickey-Fuller (ADF) test using the Akaike information criterion (AIC) and Phillips-Perron test using the Newey-West bandwidth and the Bartlett-Kernel spectral estimation method at 1%, 5% and 10% significance level are -3.626784, -2.945842 and -2.611531 respectively.

Table 1: Stationarity test

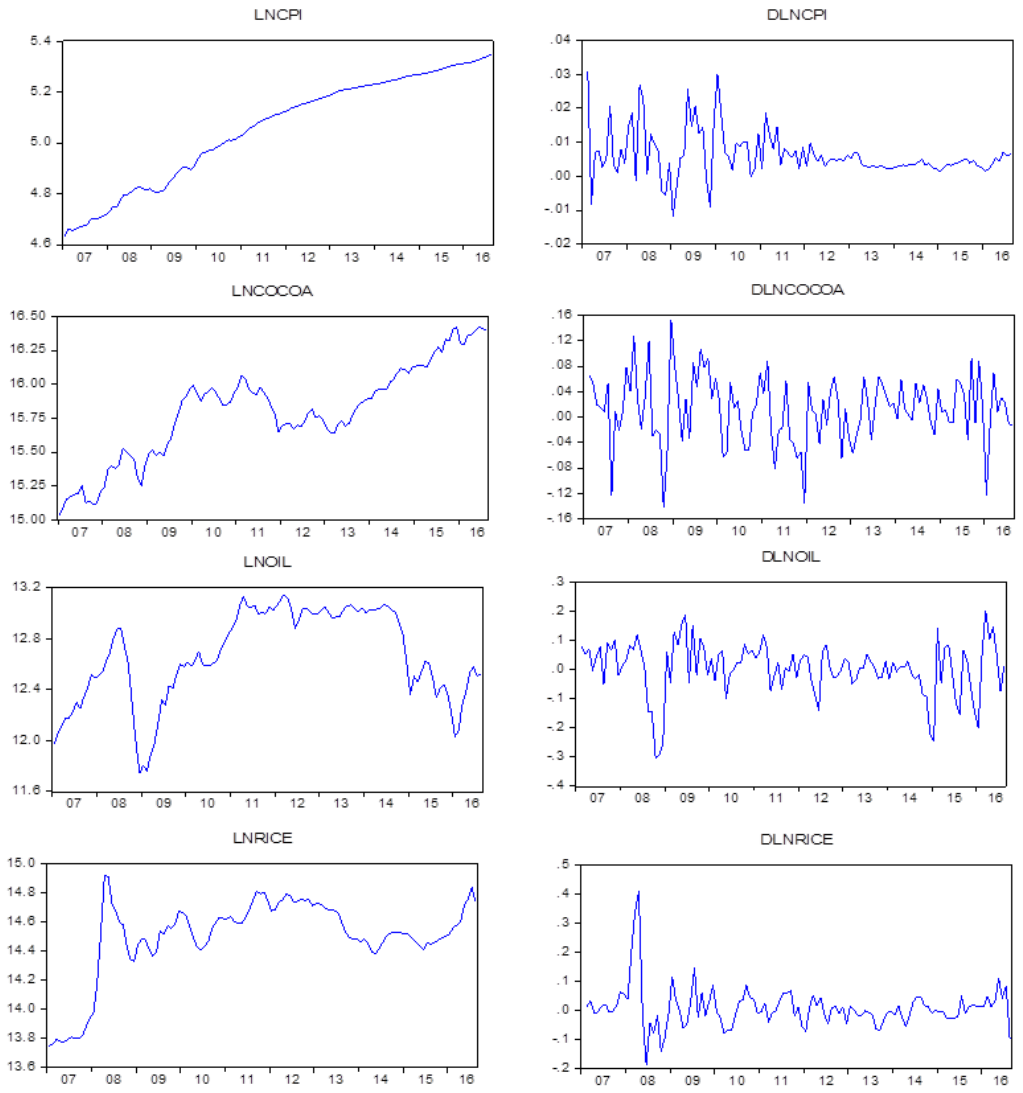
Variable	Augmented Dickey Fuller Test (Prob. Values)							
	Intercept				Intercept and trend			
	Levels	No. of lags	1st Diff	No. of lags	Levels	No. of lags	1st Diff	No. of lags
CPI	0.216	2	0.00	1	0.979	1	0.000	2
COC0A	0.643	4	0.00	2	0.519	3	0.000	3
OIL	0.111	2	0.00	2	0.378	4	0.000	2
RICE	0.085	0	0.00	1	0.154	4	0.000	3

Probabilities values reported

Stationarity (unit root) test conducted at varying lags for the set of variables enumerated and revealed that all the variables are I(1) variables (integrated of order 1); that is, they are not stationary at levels but are all stationary at their various first differences.

A graphical representation of the variables at their levels and first differences is shown in Figure 5.

Figure 5: Log levels and first differences of variables in local currency



Cointegration analysis

The Johansen cointegration test technique was employed to test for the existence of long-run relationship among the variables and the results are shown in Table 2. The unrestricted VAR model for the model was estimated using the result of the Lag Length Criteria. The optimal lag length was found to be 2. This was obtained based on the

Akaike information criterion (AIC), Schwarz information criterion (SIC), final prediction error (FPE) and the Hannan-Quinn information criterion (HQ). As shown in Table 2, it is observed that the trace test indicates 1 cointegrating equation at the 0.05 level. Similarly the maximum eigenvalue test indicates 1 cointegrating equation at the 0.05 level.

Table 2: Cointegration analysis

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.230	51.757	47.856	0.020
At most 1	0.112	22.705	29.797	0.260
At most 2	0.078	9.482	15.494	0.322
At most 3	0.003	0.352	3.841	0.552

* denotes rejection of the hypothesis at the 0.05 level.
**MacKinnon-Haug-Michelis (1999) p-values
VAR lag length: 2

Table 3: Normalized cointegrating coefficients

Normalized cointegrating coefficients (standard error in parentheses)			
CPI	Cocoa	Oil	Rice
1.000	-0.355	-0.122	-0.199
	(0.053)	(0.084)	(0.053)

Table 4: Adjustment coefficients

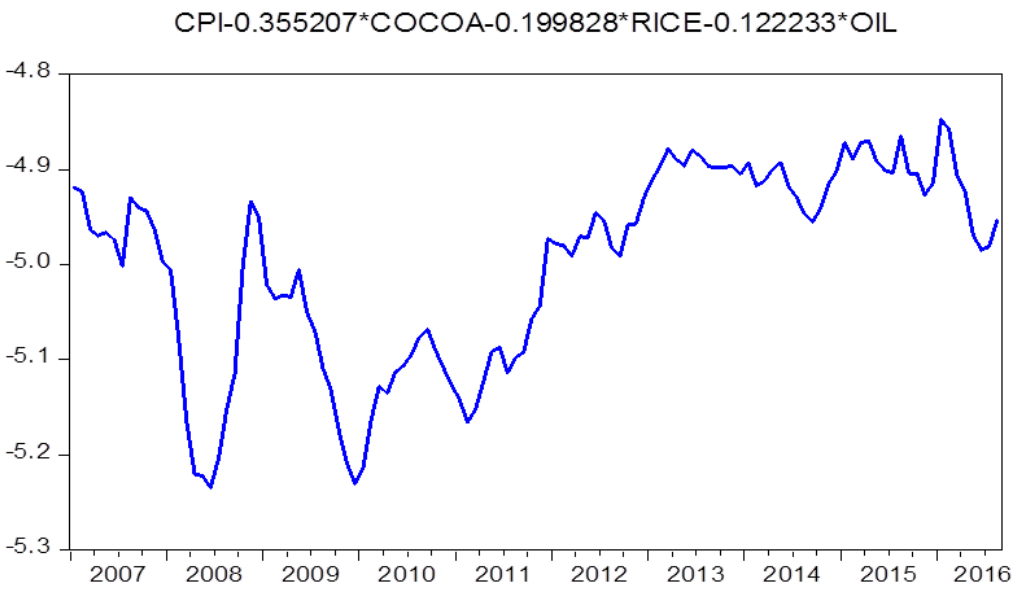
Adjustment coefficients (standard error in parentheses)			
-0.028	0.167	0.034	0.083
(0.006)	(0.066)	(0.075)	(0.105)

Table 5: Standardized cointegrating vectors

Model	Cointegrating vectors
Model	CPI- 0.355cocoa- 0.122oil - 0.199rice

Tables 3 and 4 show the normalized cointegrating coefficients, β, and the adjustment coefficients, α, respectively. The estimated standardized cointegrating vectors are given in Table 5. The results suggest the presence of a log-run relationship. This long-run relationship is substantiated in Figure 6, which depicts the graphical representation of the cointegrating vector.

Figure 6: CPI national cointegrating vector



From the cointegrating vector result, it is observed that the long-run coefficient for cocoa is 0.355. This indicates that a 1% increase in price of cocoa increases Sierra Leone's consumer prices by 0.355% in the long run. Cocoa is one of Sierra Leone's major export commodities. Therefore, a rise in the international price of this commodity is a source of windfall gain for the economy. Rising prices of cocoa leave substantial resources in the hands of the government, which most times pursues expansionary expenditure policies. In the developing world, this can be in the form of increased budgetary allocation, and wage rates. By and large, these measures are inflationary in the long-run. A 1% increase in the price of oil increases consumer prices by 0.1222% in the long-run. This largely reflects the transmission of rising oil prices to consumer prices in the economy due to the fact that the country heavily depends on oil import as the major source of energy. Similarly, a one percent increase in the international price of rice leads to a 0.1998% increase in consumer prices in the long-run. This finding is expected as rice is the staple food item in the country and it constitutes one of the country's major import commodities, as a large proportion of rice is imported regularly. A rise in the international price of such a commodity often translates directly to higher prices as imported inflation.

Weak exogeneity test

Weak exogeneity in econometric analysis relates contemporaneous explanatory variables to parameters of interest to sustain valid conditional inference and the parameters of conditional and marginal models be variation free. The test of weak exogeneity for the variables in the model is conducted and the results are shown in Table 6 below.

Table 6: Test results for weak exogeneity
Model CPI National

	CPI	Cocoa	Rice	Oil
P-value	0.000	0.437	0.791	0.373

Under the null hypothesis that the variables are weakly exogenous, the results suggest that the explanatory variables (cocoa, rice and oil) are individually weakly exogenous to CPI. In this regard, the study proceeds to apply the single equation ECM. This is done using the general to specific error correction mechanism. Here, the over-parameterized model is set in line with the model specification above and it is estimated in first differences based on the stationarity test finding that the variables are all I(1) using five lags of each of the variables along with the error correction term before the systematic transformation from general to specific.

Error correction estimation

The ECM is estimated for the model with CPI national as the dependent and the result is shown in Table 7.

The coefficient of the speed of adjustment towards equilibrium is significant and rightly signed; it implies that, relatively, 3.1% rate of errors are corrected in each month before the model returns to equilibrium. The goodness of fit of the model is found to be 50.0% which implies that 50.0% of the change in Sierra Leone's consumer prices is explained by changes in the independent variables chosen. The model is overall statistically significant as explained by the probability of the F-statistic, which is (0.00).

Table 7: Error correction estimates

Dependent Variable CPI National [ΔCPI]			
	Coefficient	t-Statistic	Prob.
Constant	0.010	9.341	0.000
ECMt-1	-0.031	-4.628	0.000
ΔCPI t-5	-0.328	-3.950	0.000
ΔCOCOA t-5	-0.016	-1.668	0.098
Δ RICE t-1	0.015	1.737	0.086
Δ RICE t-5	0.020	2.256	0.026
Δ OIL t-4	0.012	1.955	0.054
R-squared	0.500	F-statistic	6.809
Adjusted R-squared	0.427	Prob (F-statistic)	0.000
Durbin-Watson stat	2.050		

Sample (adjusted): 2007M06 2016M08 Included observations: 110 after adjustments

The study finds cocoa prices in the fifth period lag as a statistically significant variable in explaining rising consumer prices at 10% significance level. This indicates that increase in price of cocoa decreases Sierra Leone's consumer prices in the short-run. As expected, cocoa, an export commodity is a source of windfall gain for the

economy. Rising prices of cocoa can bring in foreign exchange which is often deployed in the short-run as a stabilization tool.

Oil price is found to have a significant influence on consumer prices in Sierra Leone. The result is positive, which shows that a rise in the international price of oil will translate into higher prices in the economy given that the country depends heavily on oil as its major source of energy. Therefore, both in the short-run and long-run, rising oil prices is inflationary in Sierra Leone and vice versa. Similarly, the first and fifth lag of rice price significantly lead to higher consumer prices in the economy in the short-run. This is in consonance with our expectation apriori that since rice constitutes a significant proportion of the country's total basket of imported food products, a rising rice price will be inflationary due to the pass-through effect. The fifth period lag of CPI is wrongly signed.

6. Conclusion

This study analyses the impact of commodity prices on domestic consumer prices in Sierra Leone. The study finds the commodity prices (cocoa, oil and rice) as significant determinants of inflation in Sierra Leone. In the short-run, rising price of cocoa, one of the country's major export commodities, significantly reduces the persistence of inflation in the economy. This often comes in form of sufficient foreign exchange in the hands of authorities as stabilization tools. However in the long-run, the effect is found to be reversed as rising price of cocoa is observed to be significantly inflationary. The study finds robust evidence that rising oil prices have direct and significant effects on consumer prices both in the short-run and the long-run. This is largely because the country is a primary consumer of imported fuel, with fewer alternative sources of energy. Similarly, the study finds evidence of a rising international price of rice, translating into higher domestic price in the Sierra Leonean economy both in the short-run and long-run.

Sierra Leone is essentially a supply-constrained mono-cultural economy depending on a few commodities for output and export. More foreign exchange can be earned through processing of these primary commodities to meet both the teeming domestic demand and for export. This way, more foreign exchange can be earned, the value of the local currency can be defended, and inflationary pressures mitigated. Since the study finds that rising price of cocoa is inflationary significantly in the long-run, the study recommends that monetary authorities should endeavor to build sufficient reserves from the foreign exchange earned on these commodities when the prices are high. This is because since international commodity prices are unstable, reserves should be built in the time of boom to serve as buffer stock in times of bust because boom and bust are characteristic business cycles of world economies. Additionally, the government must ensure prudent and productive utilization of resources, as extravagancy can be inflationary in the long-run. Deliberate efforts must be made to improve the productive sectors of the country to enhance self-sufficiency and to reduce importation of some of the commodities such as rice that tends to add more pressure on the value of the local currency. This can be more effective with the introduction of trade restrictions.

Furthermore, considerable attention should be given by the authorities to alternative sources of energy rather than the current overdependence on oil to reduce the direct pass-through effect of rising oil prices on consumer prices in the economy.

In this regard, consideration should be given to other alternative sources of energy such as solar and wind energy. Solar and wind energy are apparently the future trends of energy. It is common to see many households converting their homes to be powered solely by solar power. Solar energy is a good alternative to replace fuel as the major energy source as it is renewable at absolutely no cost to guarantee a constant supply of energy. Additionally, it is environment friendly. The advantages of solar energy are equally observed for wind as a source of energy. These can help reduce the current over-dependence on oil as the major source of energy as reliance on oil as a net importer has inflationary tendencies in the face of global price rise.

Additionally, building durable storehouses can be explored to take advantage of the occasional slump in global oil price. For long-run prosperity, there is need for a viable productive and manufacturing sector, which is largely the missing link in Sierra Leone's structural transformation. A vibrant production sector can largely reduce the direct pass through of external sector shocks and commodity price fluctuations to consumer prices in the economy.

Sierra Leone, being a small open economy, does not have much influence on the movement and fluctuations of international commodity prices, which can distort the equilibrium of macroeconomic fundamentals in the economy. Additionally, in this regard, domestic supply shocks can trigger domestic price rise. However, monetary policy is still a potent tool in the hands of monetary authorities. At present, the primary focus of the Bank of Sierra Leone is to achieve the price stability objective by determining the monetary policy stance, which is done by the Monetary Policy Committee (MPC). Improved monetary policy through the Bank can be instrumental in managing and preventing second-round feedback effects of commodity prices and rising inflation in the economy.

Notes

1. Theoretically, the pass-though effect of exchange rate depreciation to inflation depends very much on how much of the falling value of the currency is passed through to import prices and then to overall consumer prices.

2. Depreciation passes through directly to the prices of consumer goods, which causes inflation.

3. A country is classified as highly dollarized if its dollarization index is 30% and above. The IMF dollarization index is used as a measure of currency substitution. It is defined as the ratio of foreign currency deposits to the monetary aggregate (M2) adjusted for domestic currency in circulation.

4. The result from the analysis turns out to be similar to the national CPI estimates, therefore not reported.

5. Same conclusion was arrived at with respect to the stationarity of the variables therefore not reported.

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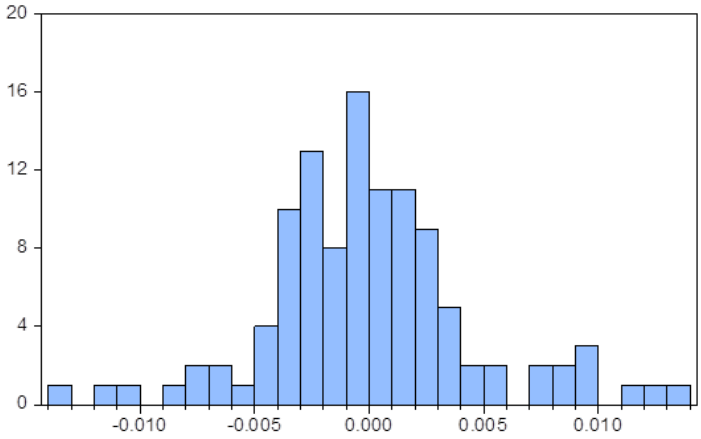
Appendix

Appendix 1: Autocorrelation and normality tests for model

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	1.750851	Prob. F(2,93)	0.1793
Obs*R-squared	3.991507	Prob. Chi-Square(2)	0.1359



Series: Residuals
Sample 2007M07 2016M08
Observations 110

Mean	-9.00e-18
Median	-0.000379
Maximum	0.013586
Minimum	-0.013231
Std. Dev.	0.004608
Skewness	0.362930
Kurtosis	4.342158
Jarque-Bera	10.67119
Probability	0.004817

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Nairobi 00200, Kenya
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