Inflation Dynamics in Zambia

Jonathan M. Chipili

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Bringing Rigour and Evidence to Economic Policy Making in Africa

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By

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Abstract

This study assesses the drivers of overall inflation in Zambia over the period 1994q1-2019q4. A single-error correction model is used in which the underlying determinants of both food and non-food components of inflation as well as supply constraints are incorporated in the overall inflation equation. The empirical results show that, in the long-run, the sources of overall inflation are determined in the external sector market where the exchange rate and world non-food prices drive domestic prices. In the short-run, overall inflation is influenced by the depreciation of the Kwacha, increases in energy prices, imported inflation from South Africa, and increases in maize prices (supply constraints). Overall inflation exhibits persistence and seasonality. Further, the two sub-components of inflation display different characteristic behavior. This underscores the importance of employing a disaggregated approach in modelling inflation to improve information content and policy response. Three policy lessons can be drawn from these empirical results. Firstly, the dominant influence of the exchange rate on overall inflation and its sub-components requires a firm policy strategy to maintain stability in the exchange rate. Secondly, expanding and diversifying the manufacturing base to limit the current high dependence on imports of final consumer and capital goods from South Africa should be prioritised. Finally, the role of supply shocks—evident in the impact of maize prices on inflation—necessitates immediate significant reforms in the agriculture sector to boost productivity through the use of modern techniques such as irrigation in order to reduce dependence on rain fed practices.

JEL Classification: *E31, F41, O55*

Keyword words: *Inflation, supply constraints, single-error correction model*

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1. Introduction

Zambia experienced episodes of high inflation between 1964[1] and the mid-1990s. Inflation was broadly in single digits between 1964 and 1974. However, it rose rapidly from 1975 and peaked at 183.3% in 1993. The key drivers of inflation during this period were excessive money supply growth induced by fiscal deficit financing, pass-through from the sharp depreciation of the Kwacha[2] and supply shocks (Mwenda, 1997; Mwansa, 1998; Pamu and Simuchile, 2004; Mutoti, 2006). However, inflation decelerated sharply to below 30% by 1997, largely driven by the impact of the tight fiscal and monetary policy stance taken as part of the broader economic reforms adopted by government in the early 1990s. Inflation returned to single digits by mid-2000, but rebounded and accelerated to 21.1% in December 2015 from 7.9% in December 2014 before receding to 6.6% in 2017. The sharp depreciation of the Kwacha against the US dollar[3], increase in domestic fuel pump prices, and reduced supply of some food items—mostly maize, the staple food[4]—contributed to the resurgence in strong inflationary pressures in 2015. The further rise in inflation in 2018 and 2019 was largely due to the depreciation of the Kwacha and increases in food prices.

High rates of inflation impose huge costs on the economy that ultimately lead to lower long-term economic growth. Inflation also creates uncertainty for firms to invest and consumers to spend, re-distributes income, generates menu costs through frequent price adjustments, and erodes the country's external competitiveness. It is for this reason that inflation remains a widely studied macroeconomic variable by both policymakers and academics. In view of this, most central banks, including the Bank of Zambia, have incorporated inflation in their statutes as a primary objective of monetary policy (Aron and Muellbauer, 2008).

By and large, no theory can adequately explain inflation, let alone identify a dominant factor of inflation (Durevall et al., 2013). Typically, demand and supply-side factors determine inflation. Demand-side factors are those that raise aggregate demand in the economy through expansionary monetary and fiscal policies. Supply-side factors reflect increases in the cost of production associated with higher wages, input price increases, higher commodity or energy prices, higher import prices, and tax increases. Domestic food supply constraints, world food price, policy changes and external shocks are other widely cited drivers of inflation. Further, weak institutional frameworks, thin financial markets, and imperfect competition among banks tend to inhibit inflation control in many sub-Saharan African countries (Durevall et al., 2013).

In recent years, a number of empirical studies, notably Diouf (2007), Durevall et al. (2013), and Adam et al. (2016), have taken a disaggregated approach in analyzing the determinants of inflations. This approach utilizes the sub-components of a price index measuring inflation and a single-equation error correction model is used to estimate the empirical model. The sub-components provide higher information content and increase inflation forecasting accuracy. This is particularly useful if the dynamic properties of individual components making up the consumer price index (CPI) vary. By utilizing sub-components, the problem of forcing each CPI component to have the same specification and response to potential factors is avoided[5]. Further, a disaggregated approach provides a deeper understanding of the underlying causes of inflation and allows central banks to respond by adopting a robust framework that considers structural influences on inflation (Akinboade et al., 2004). An elaborate estimation strategy of this approach is outlined in section 4. By and large, evidence from single-equation error correction model literature point to the sources of long-run inflation as being monetary and external in nature (Durevall and Ndung'u, 2001; Diouf, 2007; Kinda, 2011; Durevall et al., 2013; Adam et al., 2016). In the short-run, inflation is broadly driven by a combination of demand and supply-side factors.

This study builds on previous work by Mwenda (1997), Mwansa (1998), Pamu and Simuchile (2004), and Mutoti (2006) in determining the drivers of overall (headline) inflation in Zambia, but uses a disaggregated modelling approach post-liberalisation period 1994-2019. The inflation model utilizes food and non-food sub-components of the CPI used to derive inflation. The long-run determinants of food and non-food inflation determined in the external market, real money balances, as well as other potential factors suggested by theoretical models and empirical literature are incorporated in the model. The model also takes into account supply shocks, not done in previous studies, due to the significant share (55%) of food in the CPI basket (Annex 1). Durevall et al. (2013) suggested that world food prices and domestic agricultural production should be explicitly included in empirical models of inflation in developing economies where the CPI is dominated by food prices to ensure robust results.

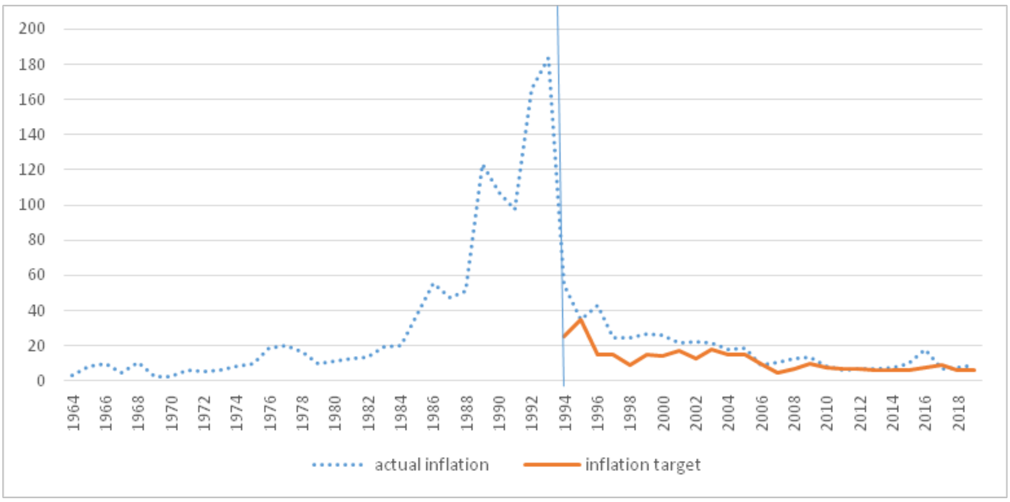
The empirical results reveal that the long-run sources of overall inflation in Zambia are determined in the external sector market where the exchange rate and world non-food prices drive domestic prices. In the short-run, overall inflation is influenced by the depreciation of the Kwacha exchange rate, increases in energy (diesel) prices, imported inflation from South Africa, and supply constraints—increases in maize prices. Further, overall inflation exhibits persistence and seasonality. The two sub-components of inflation display different characteristic behavior, thus underscoring the importance of a disaggregated approach to the modelling of inflation.

Section 2 provides a brief description of inflation in Zambia while Section 3 reviews literature focusing on studies in African countries that bear similar economic characteristics to Zambia. Section 4 presents the model specification and estimation method. Data sources and description are outlined in Section 5. Section 6 presents the empirical results. Section 7 concludes.

2. Brief description of inflation in Zambia

Inflation was relatively stable and generally below 10% prior to 1975 (Figure 1). However, inflationary pressures intensified from 1975 resulting in a record rise in inflation to 183.3% in 1993. The acceleration in inflation, particularly over the 1982-1993 period was mostly as a result of the impact of large fiscal deficits financed through central bank borrowing and the pass-through from the sharp depreciation of the Kwacha against the US dollar following the initial floatation of the Kwacha via an auction system between 1985 and 1987.

Figure 1. Actual inflation and target (annual % change): 1964-2019



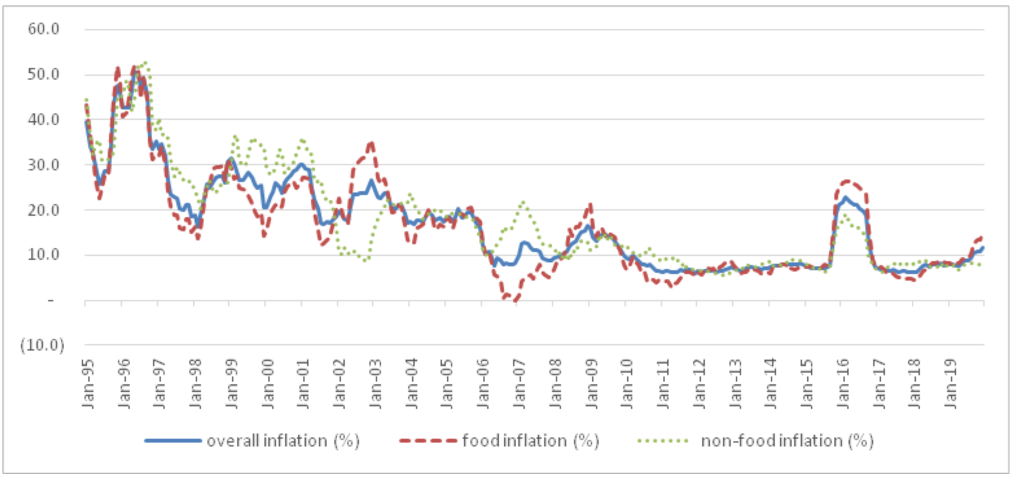
Source: Zambia Statistics Agency, Bank of Zambia and author computations

Inflation remained relatively high despite falling sharply to 54.6% in 1994. The sharp deceleration in inflation followed the implementation of economic reforms to restore macroeconomic stability. During this period, an aggressive disinflationary stance was prioritized after a prolonged period of stagflation. The reforms included trade and foreign exchange liberalization, price de-regulation, and tighter financial management. The Government also implemented a cash budget system complemented by tight monetary policy measures to restrain excessive monetary expansion (Bank of Zambia, 1994).

Inflation moderated after 1994 to below 20% in 2004 and later fell to single digits in 2006. However, it rose sharply to 14.5% in October 2015 and peaked at 22.9% in February 2016. This followed a sharp depreciation of the Kwacha against the US dollar[6]. However, inflation decelerated to below 10% by the end of 2016 as base effects[7] dissipated. Inflationary pressures re-emerged towards the end of the second quarter of 2019 leading to inflation exceeding the target range of 6-8%[8] by the end of the year. This was largely due to rising food prices and the depreciation of the Kwacha.

By and large, overall inflation tends to track food inflation (Figure 2). Excess supply of maize due to a favourable agricultural season contributed to the decline in food inflation and in turn overall inflation in 2006. Further evidence of the importance of positive agricultural supply shocks was observed in 2010 and 2017 when inflation slowed down largely on account of a maize bumper harvest. A detailed description of the importance of maize in Zambia is presented in Annex 3. Conversely, periods of drought—1995, 1998, 2001, 2003, 2005, 2013, 2015, 2016 and 2018—are associated with high inflation. The dependence of agricultural production on rainfall and the substantially large weight of food in the CPI basket makes inflation susceptible to variations in weather conditions. This underscores the significance of supply shocks on overall inflation. A large body of evidence on dependence on weather conditions and its effect on inflation exists for several sub-Saharan African countries (Diouf, 2007).

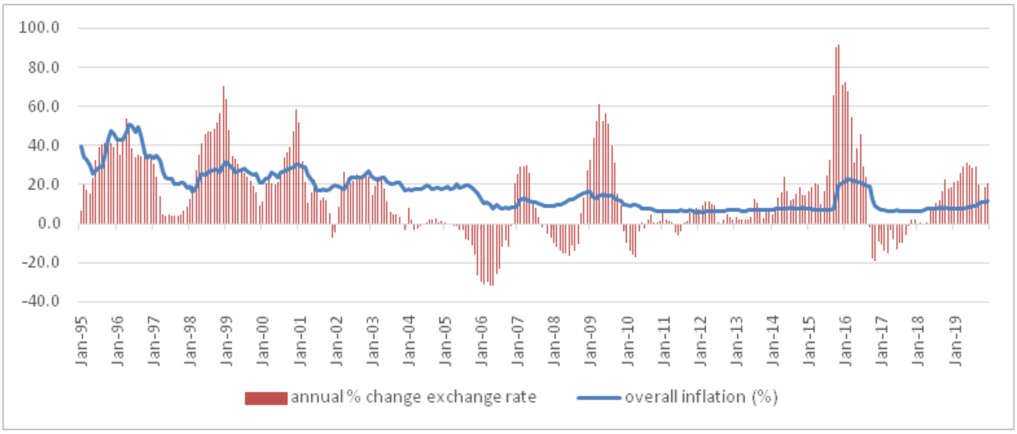
Figure 2. Overall inflation and food inflation (annual % change)



Source: Bank of Zambia and author computations

The significance of external shocks transmitted through the exchange rate and energy (crude oil) prices on inflation was notable during the 2008-2009 and post-2011 periods (Figure 3). The influence of the global financial crisis of 2008/2009 is reflected in higher inflation in 2008 and 2009 through the exchange rate channel following a marked fall in copper prices[9]. The pass-through from the depreciation of the Kwacha to CPI inflation in Zambia ranges between 0.41 and 0.49 (Zgambo, 2015). Aron et al. (2014) provide a comprehensive review and evidence on the pass-through from the changes in the exchange rate to domestic CPI in developing and emerging market economies that include Zambia. It is noteworthy that periods of sustained and occasional sharp depreciation of the Kwacha against the US dollar (1995/96, 1997/98, 2000, 2008/09, and 2015) are associated with rising inflation (Figure 3). Conversely, the fall in inflation, notably in December 2005 and May 2006 as well as between September 2016 and February 2017, is associated with the appreciation of the Kwacha.

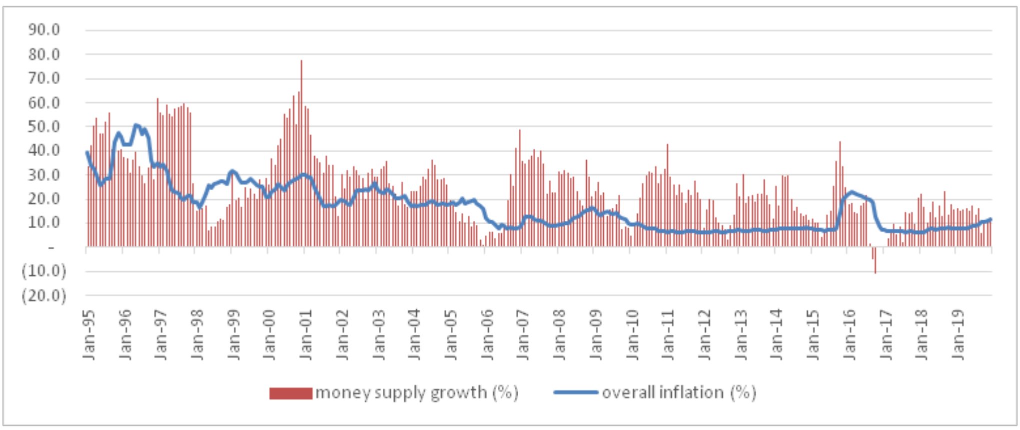
Figure 3. Overall inflation and changes in the exchange rate (%)



Source: Bank of Zambia and author computations
Note: a positive change in the exchange rate denotes a depreciation and a negative change an appreciation

There are traces of a predicted positive relationship between money supply growth and inflation with lags in figure 4. For instance, inflation generally rose when money supply grew steadily from mid-1998 and peaked in December 2000. The exception was 1999 when inflation trended downward. However, the declining trend in inflation from mid-1996 until early 1998 and between 2010 and 2011 was not associated with relatively strong money growth. The empirical association of the two variables is established in section 6.

Figure 4. Overall inflation and money supply growth (%)



Source: Bank of Zambia and author computations

Overall, inflation overshot the target for most part of the sample period (Figure 1). In view of this, a deeper appreciation of the underlying drivers of inflation is warranted for policymakers to design appropriate responses to contain inflation within the set target.

This brief discussion highlights the importance of various sources of inflation (demand-pull, cost-push, and supply shocks) that are formalized in the empirical model in section 4.

3. Literature review

Numerous models explaining the underlying causes of inflation exist. This largely reflects differences in the sources of inflation. The monetarist, Keynesian, and structuralist views constitute the key models underlying the drivers of inflation.

The monetarists believe that inflation is caused by money supply as the price level is directly affected by changes in money supply. In the long-run, inflation is driven by excess money balances as money growth exceeds output growth resulting in the increase in the general price level. To control inflation, a tight monetary policy stance is required to contain aggregate demand. For the Keynesians, inflation occurs when aggregate demand for final goods and services exceeds aggregate supply at full employment level. The structuralist theory is applicable to less developed countries where the other theories of inflation may not be directly relevant. According to this theory, supply-side constraints induce excessive growth in real money balances that ultimately leads to inflation. In addition, sectoral bottlenecks create imbalances in the process of economic development and lead to the rise in prices. The bottlenecks relate to the agriculture sector—negative supply shocks such as drought that lead to food shortages and price increases—resource constraint by Government, and shortages of foreign exchange[10].

A large body of empirical literature on the determinants of inflation exists and evidence from the empirical estimates of various inflation models is broad and diverse (Calderón and Schmidt-Hebbel, 2010). Studies on African economies tend to be convergent on the key drivers of inflation, dominated by monetary and exchange rate influence, especially in the 1970s and 1980s, before stabilization programmes were adopted and as foreign exchange markets were slowly liberalized.

This study focuses on empirical evidence from African countries with similar economic characteristics to Zambia in order to draw relevant policy lessons for the latter. Wu (2017) provides a review of numerous studies on the sources of inflation in sub-Saharan Africa, which include money growth, exchange rate changes, commodity prices, and supply shocks.

The impact of excessive money supply growth on inflation induced by fiscal deficit financing is documented. In Uganda, the inflation experienced in the 1980s is strongly attributed to excessive money supply growth driven by central bank financing of fiscal deficits (Barungi, 1997). Further, money supply and interest rates were highlighted as key short-run influences on inflation in Kenya by Durevall and Ndung'u (2001).

Akinboade et al. (2004) present evidence that the sources of inflation in South Africa tend to be structural in nature, with labour costs and money supply growth imposing strong effects on inflation in the short-run.

There is overwhelming evidence for the exchange rate as a key driver of inflation in most African countries. Durevall and Ndung'u (2001) investigated the dynamics of inflation in Kenya over the period 1974-96 and found the exchange rate and terms of trade to have strong long-run effects on inflation. In Nigeria, inflationary pressures were mainly driven by the exchange rate and petroleum prices during the period 1970-2006 (Olubusoye and Oyaromade, 2008). Suliman (2012) attributed inflation in Sudan observed over the period 1970-2002 to international prices, exchange rate, and drought. Further, Osei (2015) found inflation to be persistent in Ghana with the exchange rate and petroleum prices playing a dominant role in inflation dynamics. In Zambia, innovations in the exchange rate have been found to exert a stronger influence on inflation than money supply (Mwansa, 1998). The dominance of the exchange rate in driving inflation in most African economies reflects their over-reliance on intermediate and final consumer imports as they predominantly remain raw commodity exporters with a very small manufacturing base. As a result, these economies remain vulnerable to exchange rate and foreign inflation shocks.

The importance of supply shocks in inflation formation is also highlighted in the literature due to the significant share of food in the CPI basket of many African countries. Sowa and Kwakye (1993) and Sowa (1996) found supply factors to be dominant drivers of inflation in Ghana. In particular, output variability was identified as a key driver of inflation. In view of this, policymakers are urged to pay attention to supply factors, particularly those that affect the supply of food. This is in addition to addressing structural impediments such as road infrastructure that tend to raise distributional costs in the economy. For this reason, Sowa and Kwakye (1993) recommend a disaggregated approach to the modelling of inflation, characterizing food and non-food inflation separately, for effective policy response.

Further, Dureval et al. (2013) employed a single-error correction approach and mainly focused on the importance of food prices on overall inflation in Ethiopia due to the significance of agriculture in the economy. International food and goods prices were found to be long-run determinants of inflation while agricultural supply shocks and money supply growth underpinned inflation in the short-run. Adam et al. (2016) also employed a disaggregated approach in analyzing inflation in Tanzania in which multiple single-equation models for headline, food, energy and core inflation were estimated. Supply-side factors— agricultural output gap—and energy prices were found to be key drivers of domestic food inflation. Developments in world markets were found to influence energy price inflation while demand-side factors—excess money growth—were primarily reponsible for core inflation.

Diouf (2007) also used a single-equation approach to model inflation for Mali and concluded that the sources of long-run inflation are monetary and external in nature. This is complemented by supply-side constraints, principally rainfall which impact inflation with a lag of one and two quarters in the short-run. Further, employing a single-equation ECM approach to modelling inflation for Chad, Kinda (2011) found rainfall, foreign prices, exchange rate, and public spending as key drivers of inflation. Rainfall shocks and changes in foreign prices were found to persist for longer periods.

The main policy conclusions from the literature are that a nominal anchor for inflation in the form of a clear and well-functioning monetary or exchange rate policy is required. This is in view of the importance of money supply and the exhange rate in explaining inflation in most African countries. In addition, the policy response should be cognisant of domestic supply shocks given the dependence of many African economies on agriculture, especially rain fed production practices.

4. Model specification and estimation method

Similar to Diouf (2007), Durevall et al. (2013), and Adam et al. (2016), a single-equation error correction model is used to determine the drivers of overall inflation in Zambia. Long-run equilibrium relationships in both money and external—foreign exchange—markets are estimated first to derive error correction terms that are later incorporated in the overall inflation specification. Some factors suggested by theoretical models and empirical literature as well as deterministic terms are also incorporated in the inflation model. The single-equation model is estimated using the ordinary least squares (OLS) method. A general-to-specific approach is used to obtain a parsimonious equation.

The specification of the long-run determinants of the domestic price level is based on the postulation that inflation is typically assumed to originate from monetary and foreign sectors in an open economy setting, acting through the money demand[11] and purchasing power parity, respectively (Durevall and Ndung'u, 2001) as follows:

$$(m_t - p_t) = \emptyset_1 y_t + \emptyset_2 r_t \quad (1)$$

$$pf_t = s_t + wfp_t \quad (2)$$

$$pnf_t = s_t + wp_t \quad (3)$$

where $(m_t - p_t)$ is real money balances such that m_t is the logarithm of money supply and p_t is the logarithm of the overall domestic price level; y_t is the logarithm of real income—transaction motive for holding money; r_t is a vector of variables representing the opportunity cost of holding money or portfolio arbitrage effect reflecting precautionary and speculative motives for holding money; pf is the logarithm of the domestic food price level; s_t is the logarithm of the exchange rate; wfp_t is the logarithm of world food prices; pnf_t is the logarithm of domestic non-food prices; and wp_t is the logarithm of world non-food prices.

Equation 1 represents equilibrium in the money market. Demand for money increases in y_t and $\emptyset_1$ is assumed to be 1 under the quantity theory and 0.5 under the Baumol-Tobin model of economies of scale. Further, the demand for money is assumed to increase in the components of r_t that represent the rate of return on assets included in m_t —own rate of return or deposit rate on m_t —and decrease in the rates of return on alternative assets to m_t .[12]

Equations 2 and 3 represent a purchasing power parity (PPP) relationship for the long-run external market equilibrium for domestic food and non-food sectors, respectively. According to equation 2, domestic food prices are assumed to adjust to world food prices and the exchange rate in the long-run. Domestic non-food prices are also driven by the exchange rate and world non-food prices in the long-run. For PPP to hold, the implied long-run relationship in equation 2 $(pf_t - s_t - wfp_t$ and equation 3 $(pnf_t - s_t - wp_t)$ must be stationary or pf_t and pnf_t must closely track $s_t + wfp_t$ and $s_t + wp_t$, respectively. However, this is not always the case. To achieve stationarity in the long-run relationships, a trend or terms of trade[13] (τ_t) is usually added to equations 2 and 3 (Durevall and Ndung'u, 2001; Diouf, 2007) and re-specificied as

$$pf_t = s_t + wfp_t + \tau_t \tag{2.1}$$

and expanded and re-arranged as

$$pf_t - s_t - wfp_t = \gamma_0 + \gamma_1 \tau_t + \nu_t \tag{2.2}$$

$$pnf_t = s_t + wp_t + \tau_t \tag{3.1}$$

and expanded and re-arranged as

$$pnf_t - s_t - wp_t = \gamma_0 + \gamma_1 \tau_t + \nu_t \tag{3.2}$$

where ν_t is the error term.

If $\gamma_1 = 0$ and ν_t is stationary, then strong PPP holds such that changes in relative food and non-food prices are determined by changes in the exchange rate.

The econometric technique employed to estimate equations 1-3 depends on the time series properties of the data. If the data series are found to be non-stationary, cointegration test is conducted to establish whether or not the series in each equation are cointegrated. If cointegration is confirmed, a vector error correction model (VECM) estimation method is employed to determine the dynamics in food and non-food inflation as follows:

$$\Delta pf_t = \propto_0 + \propto_1 ecm\_rmb_{t-1} + \propto_2 ecm\_pf_{t-1} + \sum_{i=1}^{k1} \propto_{3i} \Delta pf_{t-i} + \sum_{i=1}^{k1} \propto_{4i} \Delta m_{t-i} + \sum_{i=1}^{k1} \propto_{5i} \Delta s_{t-i} + \sum_{i=0}^{k1} \propto_{6i} \Delta wfp_{t-i} + \sum_{i=1}^{k1} \propto_{7i} \Delta pnf_{t-i} + \sum_{i=0}^{k1} \propto_{8i} SC_{t-i} + \sum_{i=1}^{q} \propto_{9i} D_t + \varepsilon_t \quad (4)$$

$$\Delta pnf_t = \propto_0 + \propto_1 ecm\_rmb_{t-1} + \propto_2 ecm\_pnf_{t-1} + \sum_{i=1}^{k1} \propto_{3i} \Delta pnf_{t-i} + \sum_{i=1}^{k1} \propto_{4i} \Delta m_{t-i} + \sum_{i=1}^{k1} \propto_{5i} \Delta s_{t-i} + \sum_{i=0}^{k1} \propto_{6i} \Delta wp_{t-i} + \sum_{i=1}^{k1} \propto_{7i} \Delta pf_{t-i} + \sum_{i=0}^{k1} \propto_{8i} ep_{t-i} + \sum_{i=1}^{q} \propto_{9i} D_t + \varepsilon_t \quad (5)$$

where
ecm_rmb_{t-1} is the error correction term for real money balances derived from equation 1 defined as

$$ecm\_rmb_{t-1} = (m_{t-1} - p_{t-1}) - \emptyset_1 y_{t-1} - \emptyset_2 r_{t-1};$$

ecm_pf_{t-1} is the error correction term for domestic food prices derived from equation 2 defined as

$$ecm\_pf_{t-1} = pf_{t-1} - s_{t-1} - wfp_{t-1};$$

ecm_pnf_{t-1} is the error correction term for domestic non-food prices derived from equation 3 defined as

$$ecm\_pnf_{t-1} = pnf_{t-1} - s_{t-1} - wp_{t-1};$$

SC_t is a measure of supply-side constraint; ep_t is a measure of energy prices; D_t is a vector of deterministic terms that include seasonal dummies and impulse dummies to capture unpredictable shocks and/or regime change that are important to domestic price formation; and ε_t is a stochastic error term. The rest of the variables are as defined earlier. An optimal lag length is determined to avoid model misspecification.

Food inflation is typically a function of demand and relative price effects as well as supply-side constraints or shocks (Aron and Muellbauer, 2008). Food prices should therefore reflect variations in domestic and supply conditions. Supply-side constraints are captured by shocks to the agriculture sector, which is dominated by changes in weather conditions. Changes in weather conditions or weather related supply shocks naturally affect food supply, which makes prices volatile and therefore difficult to forecast. Thus, a measure of weather conditions in the food inflation specification equation should be included as food prices are closely related to the agricultural cycle and subject to seasonal patterns (Wu, 2017).

A positive domestic agricultural supply shock is expected to reduce domestic prices and subsequently lower inflation. Conversely, a negative agricultural supply shock drives food prices up and ultimatley increases overall inflation unless imports are allowed to cover excess demand. Average rainfall and maize price are often used as proxies for supply-side constraints (Durevall and Ndung'u, 2001; Diouf, 2007; Kinda, 2011). Rainfall is expected to affect inflation with a lag due to crop delay (Diouf, 2007). Changes in maize prices also capture short-run effects arising from the regulation of the price of the staple food by Government.

Energy prices are widely included in the specification of inflation equations (Monfort and Peña, 2008). Fuel prices are regulated by the Government due to their economy-wide impact via production and distributional effects. Rising energy prices lead to higher prices of other products, which ultimately push up overall inflation. In addition, energy costs affect consumers directly through the energy bills they incur and indirectly through the costs of products they consume that are produced using this energy. In Zambia, energy prices have a weight of about 25% in non-food inflation. Thus, its impact on inflation is expected to be notable.

The interaction between food and non-food inflation is also considered in this study similar to Wu (2017). The inclusion of non-food inflation in the food inflation equation reflects the costs faced by producers and retailers such as wages and transportation (fuel). There is support for non-food influencing food inflation in Malawi, but the pass-through from food to non-food-inflation was found to be weak (Wu, 2017). This was attributed to the substitution of the consumption of non-food consumption between domestically produced and imported goods.

To determine the dynamics in overall inflation, a single-error correction equation 6 is estimated:

$$\Delta p_t = \propto_0 + \propto_1 ecm\_rmb_{t-1} + \propto_2 ecm\_pf_{t-1} + \propto_3 ecm\_pnf_{t-1} + \tag{6}$$

$$\sum_{i=1}^{k1} \propto_{4i} \Delta p_{t-i} + \sum_{i=1}^{k1} \propto_{5i} \Delta m_{t-i} + \sum_{i=1}^{k1} \propto_{6i} \Delta s_{t-i} + \sum_{i=0}^{k1} \propto_{7i} \Delta wfp_{t-i} +$$

$$\sum_{i=0}^{k1} \propto_{8i} \Delta wp_{t-i} + \sum_{i=0}^{k1} \propto_{9i} \Delta ep_{t-i} + \sum_{i=0}^{p} \propto_{10i} SC_{t-i} + \sum_{i=1}^{q} \propto_{11i} D_t + \varepsilon_t$$

All the variables are as defined earlier. Quarterly dummies are also included to control for seasonality in inflation. Similar to Durevall et al. (2013), except for potentially endogenous variables such as the exchange rate, the rest of control variables are allowed to have a contemporaneous effect on inflation.

Equation 6 takes into account the long-run relationships defined in equations 1-3 and the short-run influence from potential determinants of inflation expressed in first difference incorporated in equations 4 and 5.

The three error correction terms $(\propto_1, \propto_2 \ and \ \propto_3)$ are included in the overall inflation model only if cointegration is confirmed for monetary and foreign sector relations defined in equations 1-3. They represent the rate of transmission to overall inflation of the previous disequilibria in the money and external markets. It is expected that $\propto_1$ will be postive as excess money balances—latent excess aggregate demand—are supposed to increase inflation. Conversly, $\propto_2$ and $\propto_3$ are expected to be negative: the domestic currency depreciation and the rise in inflation reflect a negative deviation from the equilibrium exchange rate if PPP holds.

5. Data sources and description

All the data except real GDP, world food prices, world non-food prices, and the US Treasury bill yield rate were sourced from the Bank of Zambia. Real GDP data were obtained from the Zambia Statistics Agency. The proxy for world food prices was obtained from the World Bank Commodity Price Data—The Pink Sheet—while the US Treasury bill yield rate and the proxy for world non-food prices were taken from the Federal Reserve Bank of St Louis Economic Database.

The consumer price index (CPI)—a measure of overall inflation (p_t)—incorporates both food CPI (pf_t) and non-food CPI (pnf_t) components presented in Annex 1 with 2009=100 as the base year. Actual quarterly real GDP (y_t) data were available from 2010 to 2019. For the period 1994-2009, quarterly real GDP series was generated by applying the quarterly average share of GDP for the period 2010-2017 to the 1994-2009 annual series. Money supply (m_t) represents M2 instead of M3—a comprehensive measure—as the latter was only available from 1997. M2 is M1 (Kwacha time and savings deposits plus currency in circulation) and time foreign currency deposits expressed in millions of Kwacha. The exchange rate (s_t) is the nominal quarterly average Kwacha/US dollar (K/US dollar) while (tbr_t) and ($tbrusa_t$) are the 3-month quarterly average Treasury bill yield rates for Zambia and the United States of America, respectively.

World food prices (wfp_t) is an index dominated by maize and wheat prices, which is relevant to Zambia as these two items have a substantial combined weight of 145.8 out of 550.1 in the food CPI basket as shown in Annex 2. The proxy for world non-food prices used in this study is the producer price index for South Africa ($ppisa_t$) as over 40% of Zambia's imports of manufactured goods come from South Africa. In addition, shocks to inflation in South Africa are largely transmitted to countries in Southern Africa (including Zambia) with strong trade links with the former (Chipili et. al., 2017). This evidence renders support for the choice of $ppisa_t$. Durevall et al. (2013) also used producer prices for the European Union (EU) due to strong trade links between Ethiopia and the European Union.

Energy prices (ep_t) are proxied by diesel price (dp_t). Diesel accounts for over 60% of total fuel consumption in Zambia. Supply-side constraint is proxied by maize prices due to the dominant weight of maize as a single product in the food CPI and overall CPI. Rainfall—a widely used proxy for supply-side constraint in the literature—was excluded from the estimation due to data gaps and measurement deficiencies[14]. Moreover, initial estimates revealed low explanatory power of rainfall with very small coefficient estimates.

6. Empirical results and analysis

The empirical estimates of equations 1- 6 are reported in Tables 2-5. This is preceded by the determination of the time series properties of the variables.

According to the Augmented Dickey-Fuller (ADF) unit root test results in Table 1, all the variables are non-stationary and integrated of order 1. Deterministic terms are included in the ADF unit root test specification to capture the underlying characteristic behavior of the series or data generating process for each series.

Table 1. Augmented Dickey-Fuller (ADF) unit root tests

Variables	t-ADF level	Lags	t-ADF first difference	Lags	Deter-ministic terms	Variable description
m	-2.14	0	-8.50***	2	C and T	Logarithm of money supply (M2)
rmb	-0.33	4	-5.10***	3	C	Logarithm of real money balances defined as m-p
p	-2.52	9	-5.050***	2	C and T	Logarithm of overall consumer price index
pf	-2.14	8	-3.70**	4	C and T	Logarithm of food consumer price index
pnf	-3.22	1	-8.84***	0	C and T	Logarithm of non-food consumer price index
y	-0.60	4	-3.66***	3	C	Logarithm of real GDP
s	-2.54	2	-7.25***	1	C and T	Logarithm of the nominal Kwacha/US dollar exchange rate
wfp	-1.54	2	-7.48***	1	C and T	Logarithm of the world food price index
ppisa	-3.18	7	-4.22***	10	C and T	Logarithm of the producer price index for South Africa
tbr	-2.08	5	-5.99***	4	C and T	3-month average Treasury bill yield rate for Zambia
tbrusa	-2.83	4	-4.42***	3	C and T	3-month average Treasury bill yield rate for the United States (US) of America
mp	-1.23	12	-3.58***	12	C	Logarithm of grain maize price
dp	-2.32	2	-7.80***	1	C and T	Logarithm of the pump price (retail) of diesel

***, **, and * imply 1%, 5% and 10% levels of significance. The C and T are respectively constant and linear trends included in the ADF test

To determine the long-run equilibrium in the money market, the Johansen procedure for cointegration analysis was employed. A vector autogression consisting of real money (rmb), real income (y) and interest rate differential (tbr-tbrusa) between the 3-month Treasury bill yield rates for Zambia and the US with eight lags chosen based on the modified LR test statistic was estimated[15]. The unrestricted VAR (8) passed the serial correlation, normality and heteroscedasticity misspecification tests[16].

The cointegration trace test result in Table 2 rejects the null of no cointegration and reveals evidence of one cointegrating vector.

Table 2. Cointegration analysis of the money demand function

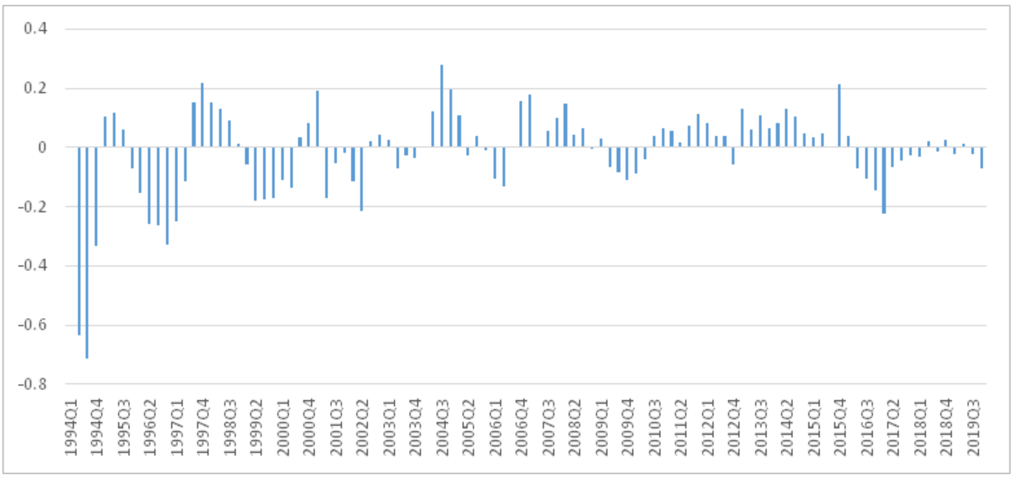
Eigenvalue	0.2027	0.1027	0.0251
Null hypothesis	r=0	r=1	r=2
λ_{trace} test	34.23	12.71	2.41
95 percent critical value	29.78*	15.49	3.84
*denotes rejection of the null hypothesis at the 0.05 level			
Normalised cointegrating coefficients (t-values in parenthesis)			
rmb_t	y_t	$tbr_t - tbrusa_t^*$	
1.00	-1.39	-0.01	
	(-25.64)	(-4.68)	
Adjustment coefficients (t-values in parenthesis)			
$d(rmb_t)$	-0.33		
	(-2.79)		
$d(y_t)$	0.02		
	(0.72)		
$d(i - i_t^*)$	16.86		
	(2.72)		
Error correction term for real money balances			
$ecm\_rmb_{t-1} = (m_{t-1} - p_{t-1}) - 2.24 - 1.39y_{t-1} - 0.01(tbr_{t-1} - tbrusa_{t-1}^*)$			
Weak exogeneity test statistics (probability values in square brackets)			
	rmb_t	y_t	$tbr_t - tbrusa_t^*$
χ^2(1)	5.5759[0.0182]	0.6167[0.4323]***	5.2104[0.0225]

*, **, and *** denote significance at 10%, 5% and 1% levels

The cointegration test results indicate a stronger response of money demand to real income—in excess of unity—than predicted by the quantity theory of money. This result is consistent with Diouf (2007) and Kinda (2011) who estimated income elasticities of 1.45 and 3.39 for Mali and Chad, respectively. The result reflects in part a high degree of monetisation of the Zambian economy (Monfort and Peña, 2008). In addition, substitution between domestic and foreign assets takes place when interest rates differ. A higher return on domestic bonds relative to US or foreign bonds increases the demand for broad money to facilitate investment in domestic bonds. This is reinforced by the liberal capital account regime Zambia adopted in 1994 that, among other measures, permits residents to hold foreign currency accounts. This allows for the substitution of domestic assets for foreign assets in response to changes in market and/or sovereign risk.

Further, the deviations of real money balances from the estimated equilibrium to which domestic prices respond is plotted in figure 5. The positive values reflect excess money supply or latent excess aggregate demand (Adam et al., 2016). Excess money supply growth was broadly low—below 0.2%—over the sample period and reduced drastically from 2016 to nearly 0%.

Figure 5 Monetary disequilibrium: 1994-2019



Sources: Author computations

Further, weak exogeneity test results indicate that real money balance and interest rate differential are endogenous while real income is weakly exogenous. This validates the assumption of money being endogenous in the specification of equation 6.

The unrestricted VAR (5) determined by the Hannan-Quinn information criterion for the food PPP relation consisting of pf_t and $s_t + wfp_t$ variables passed the serial correlation, normality and heteroscedasticity misspecification tests[17]. The null of no cointegration test was rejected by the trace test and revealed evidence of one cointegrating vector.

The cointegration results for the food PPP relation are reported in Table 3.

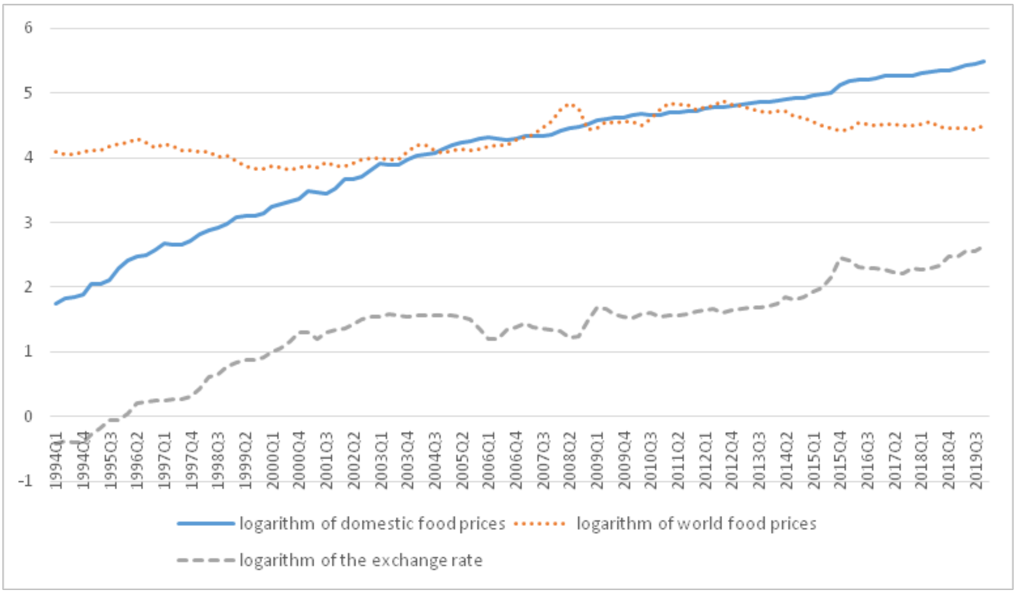
Table 3. Cointegration analysis of the food CPP PPP relation

Eigenvalue	0.1626	0.0865
Null hypothesis	r=0	r=1
λ_{trace} test	26.25	8.87
95 percent critical value	20.26*	9.16
*denotes rejection of the null hypothesis at the 0.05 level		
Normalised cointegrating coefficients (t-values in parenthesis)		
pf_t	$s_t + wfp_t$	
1.00	-0.82	
	(-11.73)	
Adjustment coefficients (t-values in parenthesis)		
$d(pf_t)$	-0.07	
	(-4.10)	
$d(s_t + wfp_t)$	-0.10	
	(-1.99)	
Associated error correction term		
$ecm\_pf_{t-1} = pf_{t-1} + 0.10 - 0.82(s_{t-1} + wfp_{t-1})$		
Unit root test for residuals from the cointegrating Food CPI PPP regression		
ADF test statistic		-9.47***
Critical values from Engel and Yoo (1987): N=1, T=100		
		1%=3.51
		5%=2.89
		10%=2.58
Weak exogeneity test statistics (probability values in square brackets)		
$\chi^2(1)$	pf	$s_t + wfp_t$
	8.4908[0.0036]	2.1994[0.1381]***

*, **, and *** denote significance at 10%, 5% and 1% levels

In the long-run, domestic food prices in Zambia are driven by the exchange rate and world food prices similar to Ethiopia as reported by Durevall at al. (2013). A 1% increase in world food prices, expressed in Kwacha, lead to a 0.82% rise in domestic food prices. The positive influence of world food prices on long-run domestic prices of food in Zambia reflects to a large extent the liberalisation of the domestic agricultural market. This is despite Government playing a dominant role in the setting of the floor maize price[18]. As shown in figure 6, the upward trend in domestic food prices, particularly during the latter part of the sample, was driven by the depreciation of the Kwacha against the US dollar. During this period, world food prices generally declined but domestic food prices maintained a rising trend. Thus, the effect of the exchange rate on world food prices expressed in Kwacha was more pronounced, hence the close link between domestic food inflation and foreign food prices. Further, the weak exogeneity test reveal that domestic food prices are endogenous while a combination of the exchange rate and world food prices—world food prices expressed in Kwacha—is weakly exogenous.

Figure 6. Plot of domestic food prices, world food prices and exchange rate



Sources: Author computations

Similar to the food CPI PPP formulation, non-food prices in Zambia are impacted by the exchange rate and world non-food prices—producer prices in South Africa—in the long-run (Table 4). A 1% increase in producer prices in South Africa lead to a 0.39% rise in domestic non-food prices. These findings are in line with Atta et al. (1999) and Kinda (2011) who confirmed the existence of a long-run external market equilibrium relationship without accounting for dynamics in the exchange rate and terms of trade. In particular, the confirmation of PPP for Botswana by Atta et al. (1999) was largely attributed to the strong trade links with South Africa. This is a similar phenomenon between Zambia and South Africa (Chipili at.al., 2017). In addition, the relatively long period of 25 years over which the PPP was estimated could partly explain the validity of the relationship.

The PPP results were derived from the unrestricted VAR (2) determined by the Akaike information criterion consisting of pnf_t and $s_t + wp_t$ variables. The residual were serially uncorrelated and normally distributed but were found to be heteroscedastic[19]. The null of no cointegration test was rejected by the trace test and revealed evidence of one cointegrating vector. Further, the weak exogeneity tests revealed that both domestic non-food prices and a combination of the exchange rate and world non-food prices—world non-food prices expressed in Kwacha—are endogenous.

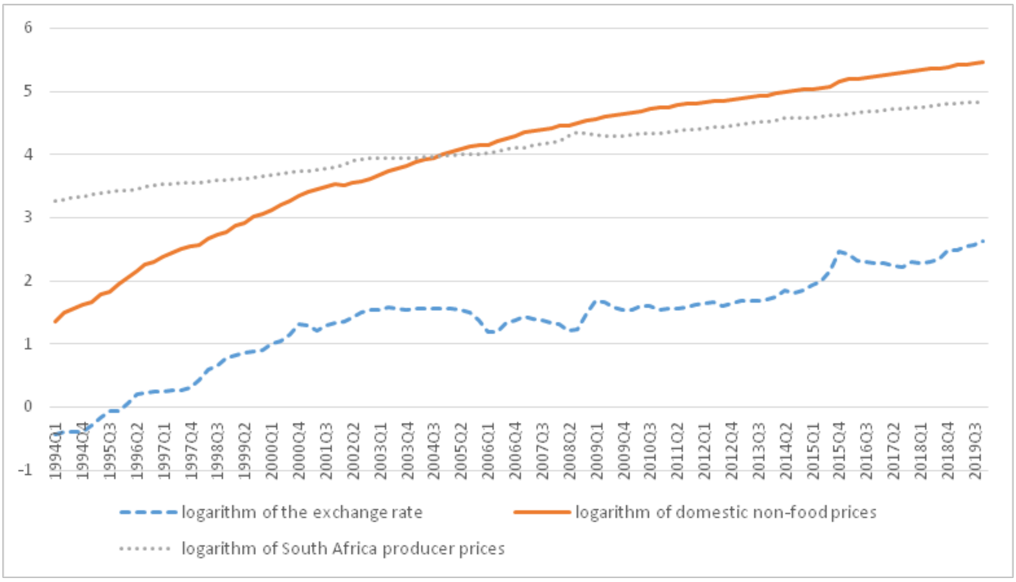
Table 4. Cointegration analysis of the non-food CPI PPP relation

Eigenvalue	0.2440	0.0114
Null hypothesis	r=0	r=1
λ_{trace} test	29.41	1.16
95 percent critical value	15.49*	3.84
*denotes rejection of the null hypothesis at the 0.05 level		
Normalised cointegrating coefficients (t-values in parenthesis)		
pnf_t	$s_t + wp_t$	
1.00	-0.39	
	(-4.01)	
Adjustment coefficients (t-values in parenthesis)		
$s_t + wp_t$	-0.03	
	(-5.39)	
$d(s_t + wp_t)$	-0.04	
	(-2.33)	
Associated error correction term		
$ecm\_pnf_{t-1} = pnf_{t-1} + 1.91 - 0.39(s_{t-1} + wp_{t-1})$		
Unit root test for residuals from the cointegrating Non-Food PPP regression		
ADF test statistic		-10.05***
Critical values from Engel and Yoo (1987): N=1, T=100		
		1%=3.51
		5%=2.89
		10%=2.58
Weak exogeneity test statistics (probability values in square brackets)		
$\chi^2(1)$	pnf_t	$s_t + wp_t$
	25.8514[0.0000]	5.3885[0.0203]

*, **, and *** denote significance at 10%, 5% and 1% levels

A plot of non-food prices, exchange rate and world non-food prices in figure 7 reveals a close upward trend hence the cointegration reported in Table 4.

Figure 7 Plot of domestic non-food prices, world non-food prices and exchange rate



Sources: Author computations

The VECMs for food, non-food, and overall inflation were estimated using the OLS method having established the existence of long-run equilibrium relationships in the money and foreign exchange markets. A general-to-specific approach was used to obtain parsimonious results for the three inflation equations reported in Table 5.

Table 5. Parsimonious inflation models

	Food CPI Inflation (Δpf_t)		**Non-Food CPI Inflation** (Δpnf_t)		**Overall CPI Inflation** (Δp_t)
constant	0.019(4.24)	constant	0.025(9.52)	constant	0.038(5.38)
Δs_{t-1}	0.084(3.05)	Δm_{t-1}	0.066(3.04)	Δp_{t-2}	-0.273(-3.57)
Δmp_{t-1}	0.028(2.44)	Δs_{t-1}	0.043(2.09)	Δp_{t-3}	0.179(2.54)
Δmp_{t-4}	0.032(2.67)	Δpf_{t-1}	0.126(2.79)	Δm_{t-2}	-0.060(-2.42)
D2	-0.022(-4.10)	Δdp	0.038(2.72)	Δm_{t-4}	-0.042(-2.03)
D3	-0.021(-4.22)	Δdp_{t-1}	0.035(2.45)	Δs_{t-1}	0.072(3.45)

Continued next page

Table 5 Continued

	Food CPI Inflation $(\Delta \boldsymbol{pf_t})$		Non-Food CPI Inflation $(\Delta \boldsymbol{pnf_t})$		Overall CPI Inflation $(\Delta \boldsymbol{p_t})$
ID1	0.058(7.75)	*ID2*	0.038(4.94)	Δs_{t-2}	0.052(2.34)
$\boldsymbol{ecm\_pf_{t-1}}$	-0.035(-4.34)	ecm_pnf_{t-1}	-0.018(-6.79)	Δmp_{t-2}	0.026(2.96)
$\boldsymbol{ecm\_rmb_{t-1}}$	0.010(0.61)	ecm_rmb_{t-1}	0.004(0.34)	Δmp_{t-3}	-0.027(-3.17)
				Δmp_{t-4}	0.028(3.44)
				$\Delta ppisa_{t-2}$	0.266(2.49)
				$\Delta ppisa_{t-3}$	-0.247(-2.28)
				Δdp	0.039(2.73)
				Δdp_{t-1}	0.028(1.98)
				D1	0.010(2.43)
				D3	-0.008(-2.18)
				ID3	0.047(5.97)
				ecm_pf_{t-1}	0.001(0.09)
				ecm_pnf_{t-1}	-0.025(-4.67)
				ecm_rmb_{t-1}	0.008(0.64)
Adjusted	0.7576	*Adjusted*	0.7735	Adjusted	0.8171
$\boldsymbol{R^2}$		R^2		R^2	
LM test	F(2,88)=1.2029	LM test	F(2,91)=0.9642	LM test	F(2,77)=0.2352
	[0.3052]		[0.3851]		[0.7910]
ARCH	F(1,96)=1.1770	ARCH	F(1,99)=0.2306	ARCH	F(1,96)=3.13e-
	[0.2807]		[0.6321]		05[0.9955]
J-B Normality	0.1195[0.9420]	J-B Normality	39.5418[0.0000]	J-B Normality	0.7723[0.6797]
RESET	F(1,89)=0.5471 [0.4615]	RESET	F(1,92)=0.2849 [0.5948]	RESET	F(1,78)=1.6805 [0.1987]

t-statistics are reported in parenthesis while p-values are in square brackets.
LM test is the Breusch-Godfrey serial correlation test; ARCH is the test for heteroscedasticity; J-B Normality is the test for the normality of errors; RESET is the Ramsey test for omitted variables or misspecification; ID1 is an impulse dummy capturing spikes in food CPI inflation in 1995q1, 1995q4, 1996q1, 1997q1, 1998q1, 2000q1, 2001q1, 2002q1, 2002q4, and 2015q4; ID2 is an impulse dummy capturing spikes in non-food CPI inflation in 1994q2, 1995q2, 1995q4, 1996q2, and 199q1; ID3 is an impulse dummy capturing spikes in overall CPI inflation in 1995q1, 1995q4, 1996q1, and 2015q4.

Four lags for all the variables in first difference, a constant, as well as seasonal dummies—*D1, D2* and *D3* —were incorporated in each inflation equation. *ID1, ID2* and *ID3* were respectively included in the food, non-food and overall inflation equations to capture unpredictable shocks that are important to domestic price formation, address non-normality errors, and deal with the problem of omitted variables[20]. Impulse dummy *ID1* largely reflects variations in food supply—mostly maize—and the sharp depreciation of the Kwacha exchange rate while *ID2* is mostly associated with excessive monetary expansion. *ID3* largely captures occasional sharp depreciation of the Kwacha exchange rate.

All the three error correction terms were included in the overall inflation equation while the food and non-food inflation equations incorporated two ECMs—money demand and the corresponding external sector ECM. Lagged values of non-food inflation entered the food inflation equation and vice versa to capture feedback between the two series. World food prices, producer prices in South Africa, diesel prices, and maize prices—exogenous variables—entered the models with contemporaneous values. Real income was not included in the VECM specifications due to little variation attributed to interpolation of GDP series prior to 2010 similar to Durevall and Ndung'u (2001).

There is no evidence of serial correction, autoregressive heteroscedasticity and regression misspecification in all the equations, including error non-normality in the food and overall inflation equations. The overall goodness of fit for all the three models is reasonably high—above 75%.

According to Table 5, food inflation is driven by the depreciation of the Kwacha and supply constraints—increases in maize prices. The exchange rate affects domestic food inflation with a one-quarter lag and its impact is larger than maize price. A 1% depreciation of the Kwacha/US dollar exchange rate leads to a 0.08% rise in food inflation while the cumulative effect of the increase in maize prices is 0.06%. Maize prices impact domestic food inflation with one and four quarter lags. Food inflation tends to be lower in the second and third quarters, largely reflecting the increase in food supply, especially maize, when the harvest period commences. The strong influence of seasonality in food inflation—replicated in overall inflation—is similar to the findings by Adam et al. (2016) for Tanzania. The spikes captured in the impulse dummy *ID1* raised food inflation over the sample period. There is absence of persistence in food inflation as none of the lagged values of food inflation is statistically significant similar to Adam et al. (2016). Further, the error correction term for the external food sector is statistically significant with the expected sign while that for the money market is statistically insignificant despite having the expected sign. Thus, in the long-run, domestic food prices are driven by the exchange rate and world food prices as reported in Table 3. However, the adjustment to disequilibrium in food inflation very is slow—at about 3.5% per quarter—and the burden of adjustment is borne by domestic food prices as foreign food prices are weakly exogenous (Table 3).

Non-food inflation is driven by the growth in money supply, depreciation of the Kwacha and increases in diesel (energy) prices. Feedback from food inflation also accounts for short-term movements in non-food inflation. Changes in food prices feed into non-food inflation via intermediate inputs used in production. Further, the spikes captured in the impulse dummy *ID2* raised non-food inflation over the sample period. The results imply that a 1% depreciation in the Kwacha/US dollar exchange rate leads to a 0.04% increase in non-food inflation with a one-quarter lag. Similarly, the growth in money supply by 1% increases non-food inflation by about 0.07% with a one-quarter lag. Increases in diesel prices have a contemporaneous impact on non-food inflation largely reflecting the first round effect via energy items in the CPI basket, which have a total weight of 25%. In addition, changes in diesel prices impact non-food inflation with a one-quarter lag. Seasonality is absent in non-food inflation similar to Adam et al. (2016) for Tanzania.

Similar to the food inflation, the money market error correction term is statistically insignificant in the non-food inflation equation despite having the expected sign. Thus, in the long-run, non-food prices are driven by the exchange rate and world non-food prices approximated by producer prices in South Africa as reported in Table 4. However, the adjustment to disequilibrium in the external market is slow—at about 1.8% per quarter—borne by both non-food and producer prices in South Africa based on the weak exogeneity test reported in Table 4. This result is counterintuitive as producer prices in South Africa are exogenously determined. It is highly likely that the endogeneity of producer prices in South Africa expressed in Kwacha is heavily influenced by the Kwacha exchange rate. This is in view of the evidence that the exchange rate is generally an endogenous variable that adjusts instantaneously to eliminate imbalances after a shock.

Consistent with the food and non-food inflation, the money market error correction term is statistically insignificant in the overall inflation equation despite bearing the expected sign. The error correction term for food prices is also insignificant and bears the unexpected sign. Thus, the statistical significance of the non-food error correction term implies that overall domestic prices in Zambia are determined by the exchange rate and world non-food prices—producer prices in South Africa—in the long-run. This result is consistent with Durevall and Ndung'u (2001), Diouf (2007), Kinda (2011) and Durevall et al. (2013), The speed of adjustment is still low, at 2.5% per quarter. Therefore, the restoration of equilibrium after a shock lasts many quarters broadly in line with Durevall and Ndung'u (2001), Diouf (2007), and Durevall et al. (2013) in which a speed of adjustment of less than 1% was found.

Overall inflation displays seasonality underpinned by the behavior of food CPI inflation due to its relatively larger weight in the CPI basket. Inflation is on average lower in the third quarter when the agricultural marketing season for maize commences, and higher in the first quarter—'lean' period (low supply amid high demand). The spikes captured in the impulse dummy *ID3*—associated with the sharp depreciation of the Kwacha against the US dollar—raised overall inflation over the sample period. There is also inertia in overall inflation, but the size of the coefficients is relatively small: inflation two quarters ago tends to reduce current inflation while inflation three quarters ago raises current inflation. Low inertia can be attributed to the decline in inflation expectations. Mishkin (2007) argued that better monetary policy tends to anchor inflation expectations. This implies that shocks to overall inflation have a temporary effect and inflation soon reverts to its trend level.

In the short-run, overall inflation is driven by the depreciation of the Kwacha, increases in energy (diesel) prices, imported inflation from South Africa, and supply constraints—increases in maize prices. The coefficient for money supply growth is statistically significant but bears the unexpected sign. The exchange rate tends to have a dominant cumulative short-run effect on inflation at lags one and two. Increases in diesel prices have a contemporaneous effect and one quarter lagged effect on overall inflation. The increase in inflation due to the rise in maize prices at lag two is offset by the lag three but the net impact on inflation is positive due to the relatively large coefficient at lag four. Durevall and Ndung'u (2001) also confirmed the influence of maize prices on inflation in Kenya. The cumulative effect of imported inflation from South Africa at lags two and three on inflation is also positive.

A notable observation from the empirical results is that money supply did not appear to have a long-run influence on prices in Zambia over the sample period[21]. However, the growth in money supply had short-run effects only on non-food inflation. This result is similar to Durevall and Ndung'u (2001), Kinda (2011), and Durevall et al. (2013) for Kenya, Chad and Ethiopia as reported, respectively. It is possible that money supply may have had an indirect effect on inflation via the exchange rate although this relationship is not investigated in the current study. Nonetheless, the results from the money demand function estimate in Table 2 show that excess money supply was very low over the sample period—below 0.2%—to meaningfully induce inflationary pressures. This still demonstrates the relevance of money supply in the evolution of domestic prices, which the monetary authorities cannot ignore. This calls for the monetary authorities to continue paying attention to money supply growth as a potential source of inflation.

7. Conclusion

This study assessed the underlying drivers of overall inflation in Zambia over the period 1994-2019 using quarterly data. Monetary and external factors as well as supply constraints were considered. A single-error correction model was used in which the underlying determinants of both food and non-food components of inflation and supply constraints were incorporated in the overall inflation equation.

The empirical results have revealed that the long-run sources of overall inflation are determined in the external sector market where the exchange rate and producer prices in South Africa drive domestic prices. In the short-run, overall inflation is influenced by the depreciation of the Kwacha exchange rate, increases in energy (diesel) prices, imported inflation from South Africa, and supply constraints—maize prices. In addition, overall inflation exhibits persistence and seasonality. A diminished role of money supply in inflation dynamics over the sample period is established. This contrasts evidence from previous studies that identified money supply as one of the key determinants of inflation.

The two sub-components of inflation display different characteristic behavior while inertia is absent in both food and non-food inflation, the former exhibits seasonality, reflecting largely the influence of weather conditions on maize—predominately rain fed—that dominates the food sub-index. In the long-run, domestic food and non-food prices are influenced by developments in the external sector where world food prices and producer prices in South Africa adjusted for the exchange rate matter. In the short-run, the drivers of domestic food inflation are the depreciation of the Kwacha and supply constraints—maize prices. In the case of non-food inflation, the growth in money supply, depreciation of the Kwacha, and increases in diesel (energy) prices matter in the short-run. These findings underscore the importance of a disaggregated approach to inflation modelling which helps in identifying the underlying characteristic behaviour of each sub-component.

The empirical results have reconfirmed the dominant role of the exchange rate in accounting for swings in overall inflation and its sub-components. This underscores the need for the authorities to consistently implement policy actions to dampen excessive depreciation of the Kwacha exchange rate. In addition, the significance of imported inflation from South Africa requires policies to expand and diversify the manufacturing base in Zambia to limit the current high dependence on South Africa for imports of final consumer and capital goods. The share of food imports from South

Africa in total food imports is about 50%. Thus, any shock to food production and/or prices in South Africa are immediately transmitted to Zambia.

The role of supply shocks—evident in the impact of maize prices on inflation—point to the need for significant reforms in the agriculture sector to boost productivity through the use of modern techniques such as irrigation to reduce dependence on rain fed practices. In addition, better use of fertilizer, improved seed and access to credit, especially among poor rural households should contribute to boosting productivity. Further, investment in the road infrastructure, especially feeder roads in rural areas, and improved storage facilities to mitigate distributional and overhead costs should moderate agricultural product prices and ultimately stabilize inflation.

Notes

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1. Zambia gained her political independence from the British colonial rule in 1964.

2. To eliminate the parallel market for foreign exchange, which had emerged during the fixed regime; improve the allocation of foreign exchange previously done on non-price criteria; and allow supply and demand to interact in determining the exchange rate, the Kwacha was allowed to float against major currencies in October 1985 via a Dutch auction system. However, the auction was suspended in January 1987 and a fixed exchange rate system re-instated after the Kwacha lost over 530% of its value against the US dollar over a 16-month period.

3. The sharp depreciation of the Kwacha was mainly driven by excessive government spending, falling copper prices, widening current account deficit, and the strengthening of the US dollar (Bank of Zambia, 2015).

4. Maize has a relatively larger weight in the food CPI basket (Annex 2). The total weight of maize as a single product is 64.98, representing 11.8% and 6.5% in the food CPI and overall CPI, respectively. The weight of 64.98 is broken down as follows: maize mealie meal (breakfast)=32.26; maize mealie meal (roller)=16.77; and maize grain=15.95.

5. The aggregate CPI modelling approach assumes that factor elasticity is the same across all the CPI components (Aron and Muellbauer, 2008).

6. The depreciation was attributed to lower copper prices due to the slowdown in China, uncertainty regarding the performance of the mining sector, stronger US dollar, deteriorating current account balance, widening fiscal deficit, sovereign rating downgrade and the impact of electricity shortages on economic activity (Bank of Zambia, 2015).

7. The base effect relate to the dissipation of the impact of the sharp rise in the consumer price index in October 2015, occasioned by the unprecedented depreciation of the Kwacha against the US dollar, which was removed from the annual comparison a year later resulting in the fall in inflation.

8. The Government introduced a target band of 6-8% in 2018 as a precursor to inflation targeting.

9. Copper is Zambia's main export commodity, accounting for over 70% of foreign exchange earnings. Chipili (2016) provides evidence that the Kwacha is a commodity currency—movements in the Kwacha exchange rate are affected by movements in the copper price over time. In turn, the exchange rate influences inflation.

10. It is argued that agricultural output, especially grain production, does not respond to changes in income due to constraints such as disparities in land ownership, distortions in land tenure, use of outdated technology, and lack of knowledge and access to finance. In terms of resourc constraint, government prints money to invest in infrastructure, which in turn generates inflationary pressures in an attempt to boost capital formation to support growth. To resolve shortages of foreign exchange, the government devalues the currency to encourage exports, which in turn raises domestic prices and subsequently lead to inflation.

11. The monetary authorities are able to control inflation through appropriate adjustments to money supply when the money demand function exhibits stability as changes in money supply are closely related to prices and income.

12. Alternative assets include foreign bonds, domestic goods—inflation (Δp_t) representing the fall in the demand for m_t in preference for domestic goods as the purchasing power of m_t is eroded, and exchange rate (Δs_t)—currency subsitution when the domestic currency deprecuates against foreign currencies and agents shift to holding more foreign assets.

13. These reflect transaction costs, differences in productivity among countries, and other impediments to trade.

14. Some meteorological stations did not report rainfall data, which affected the accuracy of actual rainfall in each period. In addition, rainfall data included non-principal food-producing districts.

15. The results for the other proxies of the opportunity of holding Kwacha balances—inflation and exchange rate depreciation—plus the own rate of return on money proxied by the deposit rate were less robust. The estimated coefficients had either unexpected signs, were statistically insignificant or showed no existence of cointegration relation among variables.

16. LM serial correlation test: F(1-9)=7.7316[0.5614]; Normality test: χ^2 (3)=4.4031[0.2211]; and Heterosekedasticity test: χ^2 (288) =277.2194[0.6653]

17. LM serial correlation test: F(1-6)=3.0007[0.5577]; Normality test: χ^2 (1) =1.1963[0.5498]; and Heterosekedasticity test: χ^2 (195) =215.0843[0.1544]

18. Maize prices are influenced by the Government through agencies created by an Act of Parliament. These agencies—previously crop marketing boards—administer national food reserves. Food reserves serve as a buffer stock to cushion maize price variability and provide liquidity in the maize market. In addition, trade in maize is regulated by the Government through the issuance of export and import licenses. Under this arrangement, the prevailing maize price may not necessarily reflect supply shortages in the food sector as the Government may import maize and sell at below market price to keep the price of mealie meal low. Maize prices are also set above the market to support producers, but subsidize millers by selling maize grain at lower prices to manage final consumer mealie meal prices. Export of maize is regulated by Government through export permits, but the private sector generally considers prevailing international prices in the setting of domestic prices due to active cross-border trade with neighbouring countries mostly the Democratic Republic of Congo, Malawi and Zimbabwe.

19. LM serial correlation test: F(1-3)=2.3382[0.6738]; Normality test: χ^2 (1) =6.2215[0.1832]; and Heterosekedasticity test: χ^2 (42) =66.8417[0.0087]

20. Nonetheless, the errors in the non-food inflation equation remained non-normal reflecting, to some extent, the presence of extreme values in the data series similar to Adam et al. (2016).

21. Simpasa et al. (2014) provided evidence of a weakening link between money supply and inflation based on volatile and declining velocity of money accompanied by rising money multiplier. This contributed to the observed inverse relationship between broad money growth and inflation and could have influenced the central bank to switch from the monetary targeting regime to using interest rates in signalling the stance of monetary policy.

22. Of which the total weight of maize is 64.98, representing 11.8% and 6.5% in the food CPI and overall CPI, respectively as a single product. The weight of 64.98 is broken down as follows: maize mealie meal (breakfast)=32.26; maize mealie meal (roller)=16.77; and maize grain=15.95.

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Annexe

Annex 1

CPI main groups (2009 Base Year)		**CPI main groups (1994 Base Year)**	
	Weight		**Weight**
Food Items	550.1	Food Items	571
Food and Non-Alcoholic beverages	*534.9*	*Food and Beverages*	*571*
Alcoholic beverages and tobacco	*15.2*		
Non-Food Items	450.0	Non-Food Items	429
Clothing and footwear	80.8	*Clothing and footwear*	68
Housing, water, electricity, gas and other fuels	114.1	*Rent, fuel and lighting*	85
Furnishings, household equipment, and routine house maintenance	82.4	*Furniture and household goods*	82
Health	*8.2*	*Medical care*	*8*
Transport	*58.1*	*Transport and communication*	*96*
Communication	*12.9*		
Recreation and culture	*13.8*	*Recreation and education*	*49*
Education	*26.6*		
Restaurant and hotel	*3.4*		
Miscellaneous goods and services	*49.7*	*Other goods and services*	*41*
All Items	1000		1000

Sources: Central Statistics Office, Prices Statistics, 2014

Annex 2. Main components of food items

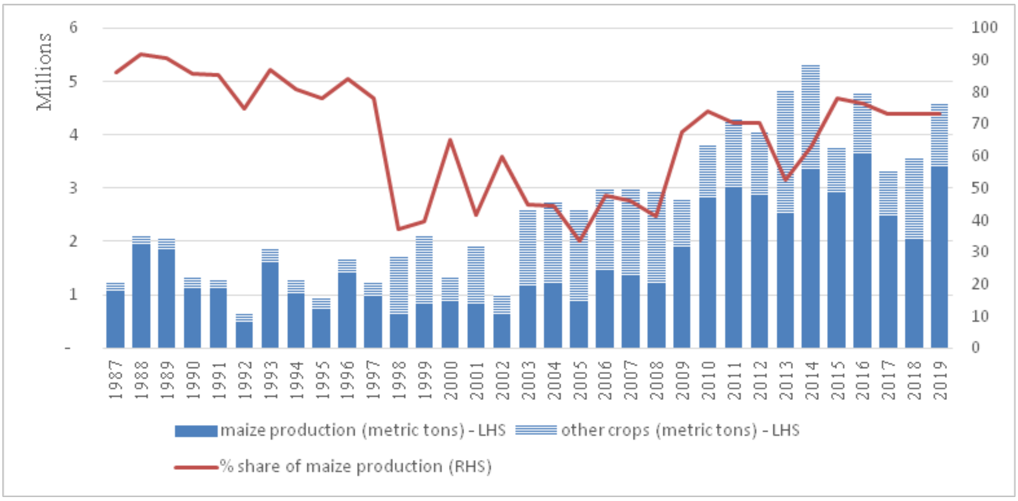
Food sub-group	**Weight**
Bread and cereals[22]	*145.831*
Meat	*82.723*
Fish	*89.084*
Milk, cheese and eggs	*23.629*
Oils and fats	*40.006*
Fruits	*17.754*
Vegetables	*74.223*
Sugar, jam, honey, chocolate and confectionary	*34.837*
Other food products	*17.442*
	525.523
Non-alcoholic beverages	8.577
Alcoholic beverages	13.687
Tobacco	1.476

Source: Central Statistics Office, Prices Statistics, 2014

Annex 3

In Zambia, agricultural output is dominated by crop production with maize—staple crop—accounting for the largest share in excess of 60% (Figure A). This is largely as a result of Government support programmes—input subsidies and marketing services—that have led to the promotion of maize as a major agricultural crop predominantly produced by smallholders across the country who depend exclusively on rainfall. In view of this, shocks to rainfall patterns significantly impacts the supply of maize and in turn its price. Besides the weather, maize output is affected by fertilizer use and seed variety.

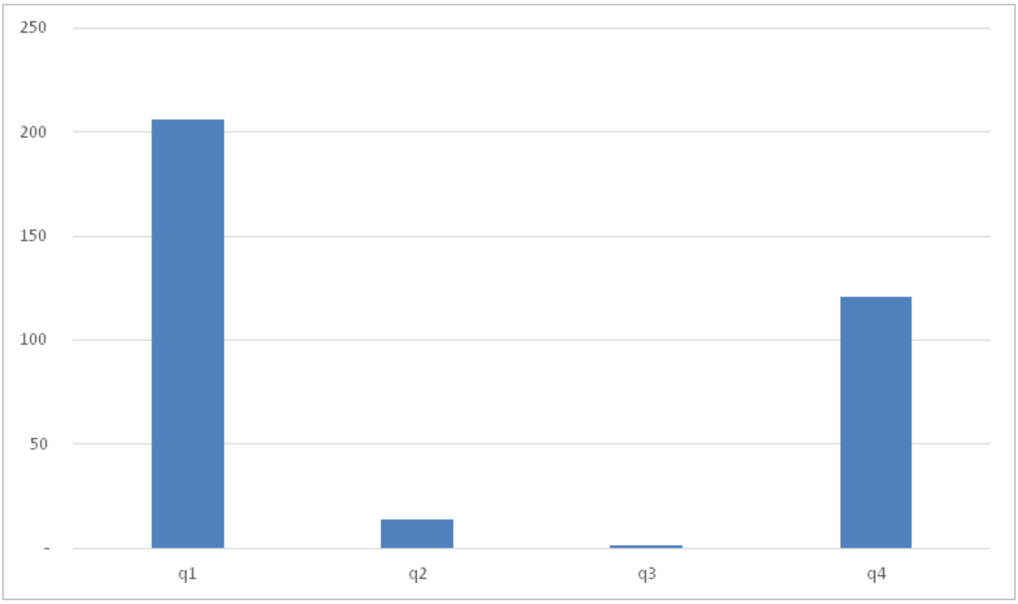
Figure A. Crop production and share of maize: 1987-2019



Source: Ministry of Agriculture and Author Computations

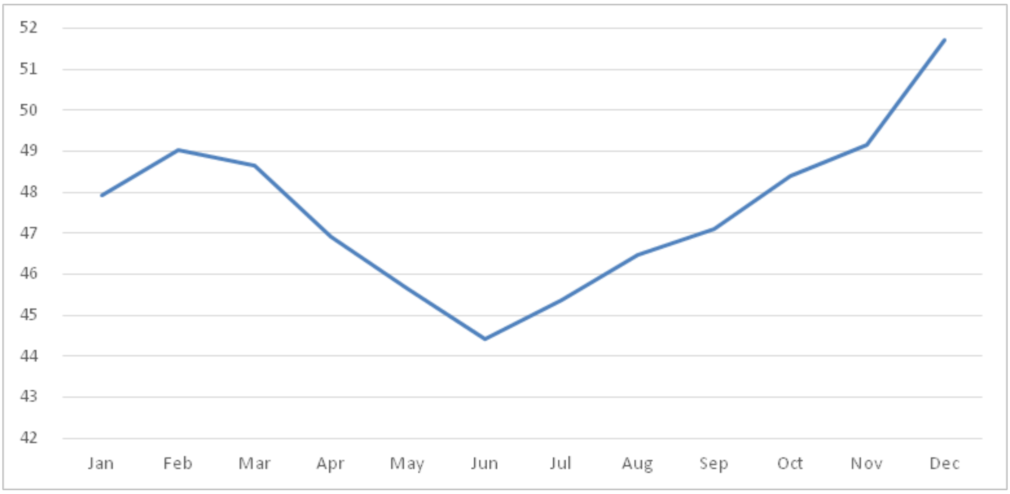
Figure B shows the average rainfall pattern over the 1994-2019 period. The rainy season runs from December to April. Rainfall progressively declines from May and is at its lowest around June/July. Due to the dependence on rainfall, maize is grown between December and April (lean period – low supply amid high demand). During this period, maize prices are relatively high but decline in the second and third quarters—harvest period—and are usually at their lowest in the latter quarter (Figure C). The gradual fall in maize prices from the end of the first quarter—preceding the onset of the marketing period—partly reflects Government intervention through the sale of cheaper maize grain from strategic reserves as well as reduced demand for maize grain and its products as alternative food items become available. This tends to dampen the price of the staple food.

Figure B. Quarterly average rainfall pattern (mm): 1994-2019



Source: Zambia Meteorological Department and author computations

Figure C. Trend in monthly average maize price (Kwacha/50kg bag): 1994-2019



Source: Bank of Zambia and author computations

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To strengthen local capacity for conducting independent, rigorous inquiry into the problems facing the management of economies in sub-Saharan Africa.

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