Inflation Dynamics in Zambia

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Bringing Rigour and Evidence to Economic Policy Making in Africa

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Abstract

This study assesses the empirical drivers of inflation in Zambia over the period 1994.1-2019.4. 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 reveal that the long-run 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 movements in the exchange rate, adjustments in energy prices, imported inflation from South Africa, and changes in maize prices (supply constraints). In addition, the results show that overall inflation exhibits persistence and seasonality. Further, the two sub-components of inflation display different characteristic behaviours. This underscores the importance of employing a disaggregated approach to modelling inflation in order to improve information content and policy response. Three policy lessons can be drawn from these empirical results. The dominant influence of the exchange rate on overall inflation and its sub-components deserves serious policy attention requiring consistent actions to dampen excessive depreciation of the Kwacha against the US dollar. In the case of the pass-through from imported inflation, expanding and diversifying the manufacturing base to limit the current high dependence on imports of final consumer and capital goods remains a policy priority. Finally, the role of supply shocks evident in the impact of maize prices on inflation necessitate 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

Key words: Inflation, sub-components, supply constraints, single-error correction model

I. Introduction

Zambia experienced prolonged episodes of high inflation prior to the mid-1990s. Inflation was less than 1% in 1964 but rose rapidly thereafter and exceeded 180% by 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[1] and supply shocks (Mwenda, 1997; Mwansa, 1998; Pamu and Simuchile, 2004; Mutoti, 2006). However, following implementation of economic reforms in early 1990s, inflation decelerated sharply to below 30% by 1997. By mid-2000, inflation had dropped to single digits and remained anchored around 10%. However, inflation rebounded and accelerated to 21.1% in December 2015 from 7.9% in December 2014 before receding to 6.6% in 2017. The increase in inflation during this period was mainly due to the significant depreciation of the Kwacha against the US dollar[2], upward adjustment in fuel pump prices, and reduced supply of some food items, mostly maize—the staple food.

High rates of inflation can undermine macroeconomic stability and subsequently impose huge costs on the economy that ultimately lead to lower long-term level of economic growth. In addition, inflation 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. Despite a long history of research interest, policymakers and academics alike continue to focus on inflation and the significance of inflation is now incorporated in most statutes of central banks as a core deliverable (Aron and Muellbauer, 2008). For example, in Zambia, price stability is incorporated in the Bank of Zambia Act No. 43 of 1996 in section 4(1) as a primary function.

By and large, no theory can adequately explain inflation, let alone identify a dominant factor of inflation (Durevall et al, 2013). In an open economy setting, inflation is assumed to originate from monetary and foreign sectors acting through the money demand and purchasing power parity, respectively (Durevall and Ndung'u, 2001). Typically, demand-side and supply-side factors underlie 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 increases that ultimately raise domestic food prices, policy changes and external shocks such as poor harvests and energy price hikes are other widely cited drivers of inflation. It is noted that 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).

Similar to Diouf (2007), Durevall et al (2013), and Adam et al (2016), this study employs a single-equation Error Correction Model (ECM) approach in analysing the drivers of overall inflation in Zambia over the period 1994-2019 (post-liberalization) using quarterly data. Both short-run and long-run determinants of the sub-components of inflation are incorporated in a single-equation inflation model. The short-run determinants include control factors in the long-run equilibrium model for both money and domestic food as well as non-food prices and other potential factors suggested by different theoretical models and empirical literature. The long-run determinants are derived from equilibrium relations specified in both money and external markets from which the error correction equations are obtained.

Mwenda (1997), Mwansa (1998), Pamu and Simuchile (2004), and Mutoti (2006) took an aggregated approach to modelling inflation in Zambia. However, recent literature, especially relating to inflation forecasting, emphasizes and recommends a disaggregated approach using the sub-components of the price index. 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 same response to potential factors is avoided. The aggregate CPI modelling approach assumes that factor elasticity is the same across all the CPI components (Aron and Muellbauer, 2008). Further, a disaggregated approach provides a deeper understanding of the underlying causes of inflation and allows central banks to respond appropriately by adopting a robust response framework that considers structural influences on inflation (Akinboade et al, 2004). With this approach, each component constituting the inflation measure is estimated separately, considering its underlying factors, and then incorporated in the aggregate CPI equation as described in section 4.

In this study, food and non-food inflation (the two main components of the CPI) are estimated separately based on their underlying factors over the period 1994.1-2019.4. In turn, the overall inflation model incorporates underlying factors from the two sub-components of the CPI. In addition, the food and overall inflation models take into account supply shocks due to the significant share of food in the CPI basket. This is done to avoid obtaining biased estimates and misguiding policy decision. This aspect of inflation analysis is absent in previous studies on inflation in Zambia. The significance of agriculture in Zambia is reflected in a large share of food of 55% (Annex 1) in the CPI basket and, therefore, requires an explicit inclusion of supply or agricultural output shocks in the modelling of inflation. Further, the food CPI is dominated by maize (bread and cereals sub-group), the staple food (Annex 2). Therefore, changes to maize output due to variations in the weather pattern impose significant effects

on food inflation and in turn on overall CPI inflation. This is largely attributed to the high dependence of agricultural production on rainfall in Zambia. Durevall et al (2013) suggested that world food prices and domestic agricultural production should be explicitly included in the empirical models of inflation in developing economies where the CPI is dominated by food prices to ensure robust results.

Durevall and Ndung'u (2001) used a single-equation ECM in which the exchange rate, foreign prices and the terms of trade were found to be the key drivers of inflation in Kenya in the long-run. In the short-run, inflation was mainly influenced by growth in money supply and maize prices. 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. In the short-run, supply-side constraints, principally rainfall, impact inflation with a lag. Further, using a single-equation ECM approach to modelling inflation for Chad, Kinda (2011) identified rainfall, foreign prices, exchange rate, and public spending as key drivers, and that rainfall shocks and changes in foreign prices tend to persist for longer periods. Adam et al (2016) estimated multiple-determinant single equation models for overall inflation and its major components (food, energy, and core inflation) in Tanzania. They established supply-side factors in driving domestic food and energy inflation while demand-side factors are crucial in explaining core inflation.

The empirical results reveal that the long-run 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 movements in the exchange rate, adjustments in energy prices, imported inflation from South Africa, and changes in maize prices (supply constraints). In addition, overall inflation exhibits persistence and seasonality. Further, the two sub-components of inflation display different characteristic behaviours.

The rest of the paper is structured as follows: Section 2 provides a brief description of inflation in Zambia. Section 3 reviews the literature, focusing on African studies 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 and Section 7 concludes.

2. Brief description of inflation in Zambia

Inflation was relatively stable prior to 1974 except for a spike in 1971 (Figure 1). However, inflationary pressures intensified from 1975 and reached 9.1% by 1982. Inflation peaked at 183.3% in 1993. The acceleration in inflation over the 1982-1993 period was mostly as a result of the impact of large fiscal deficit financing through central bank borrowing and the pass-through from the significant 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
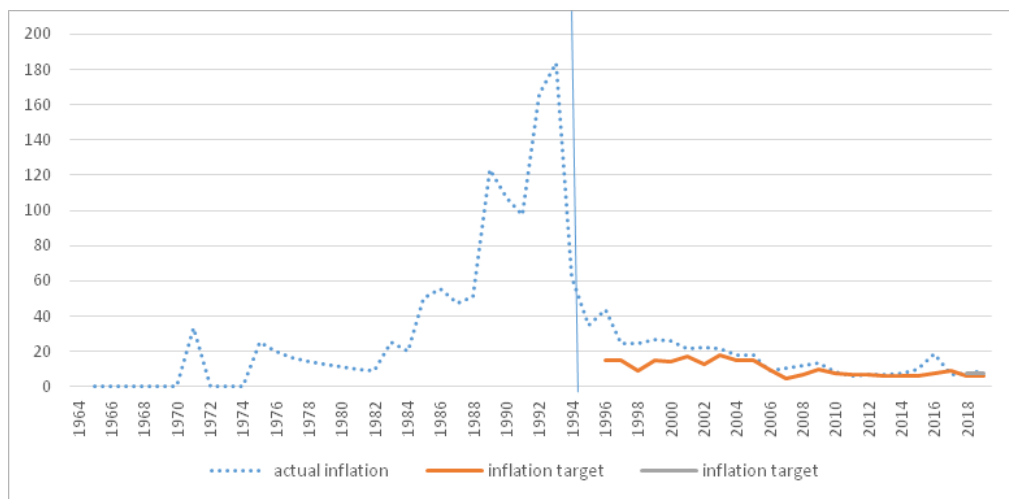
Source: Zambia Statistics Agency, Bank of Zambia and author computations

Inflation fell sharply in 1994 to 61.9%, but remained relatively high. This followed the implementation of economic reforms to restore macroeconomic stability, during which 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. In addition, the government implemented a cash budget system complimented by tight monetary policy measures to restrain excessive monetary expansion (Bank of Zambia, 1994).

Inflation moderated after 1994, declining to below 20% in 2005 and later fell to single digits (8.2%) in 2006 after more than three decades. However, in October 2015, inflation rose sharply to 14.5% and peaked at 22.9% in February 2016. This followed a sharp depreciation of the Kwacha against the US dollar occasioned by lower copper prices attributed to the slowdown in China, uncertainty over the performance of the mining sector (with Glencore scaling down its operations at Mopani), 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).

However, inflation decelerated to below 10% by the end of 2016 as base effects dissipated. However, inflationary pressures re-emerged towards the end of the second quarter of 2019 leading to inflation exceeding the target range of 6-8% by the end of the year. The government introduced a target range of 6-8% in 2018 as a precursor to inflation targeting. A notable observation about the dynamics in inflation over the sample period is that it broadly trended above the target (Figure 1). In this regard, a deeper understanding of the underlying drivers of inflation will allow the authorities to design appropriate policy response to align and contain inflation within the set target.

Broadly, inflation in Zambia tends to closely track food inflation (Figure 2). Excess supply of maize due to a favourable agricultural season contributed to the decline in inflation in 2006. Further evidence of the importance of positive agricultural supply shocks was observed in 2006, 2010 and 2017 when inflation slowed down largely on account of a maize bumper harvest. Conversely, periods of drought (that is 1995, 1998, 2001, 2003, 2005, 2013, 2015, 2016 and 2018) are associated with high inflation. Thus, 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. A large body of evidence on the 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)
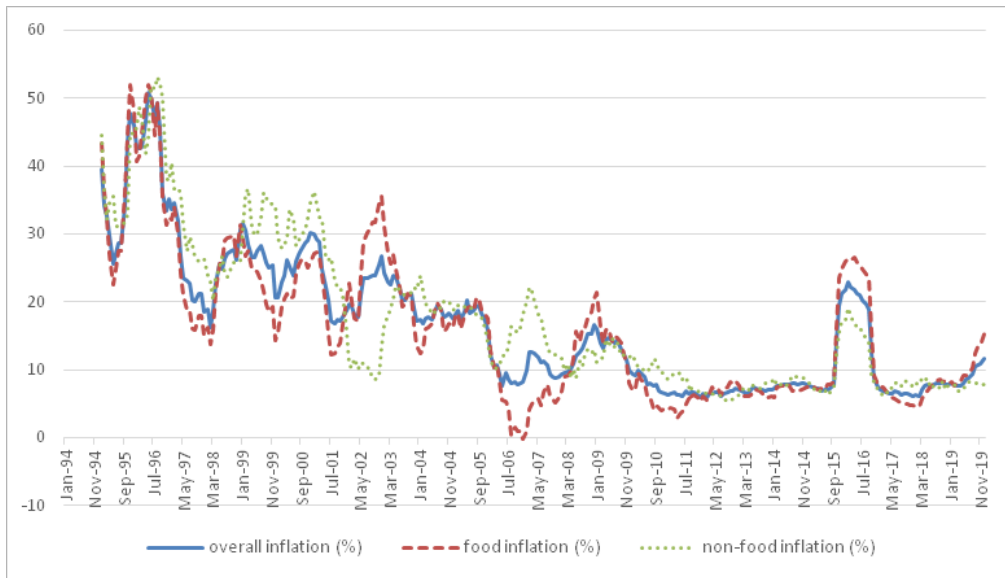
Source: Bank of Zambia and author computations

This underscores the significance of supply shocks on overall (headline) inflation. Agriculture output in Zambia is dominated by crop production of which maize has the largest share in excess of 60% (Figure 3). By and large, agricultural policies have been largely skewed towards the promotion of maize production as the major staple crop. Subsidies are extensively used to support production and manage the maize price. The focus on maize self-sufficiency through various Government support programmes (input subsidies and marketing services) has led to the promotion of maize as a major agricultural crop in the smallholder sector. Maize is predominantly produced by smallholders across the country who depend exclusively on rainfall. As a result, maize output fluctuates significantly from year to year due to changes in rainfall patterns. Any shock to rainfall patterns significantly impacts the supply of maize and in turn its price[3]. Figure 4 shows the rainfall pattern over the sample period. The rainy season runs from December to April. Rainfall progressively declines from May and is at its lowest around June/July.

Figure 3. Crop production and share of maize: 1987–2019
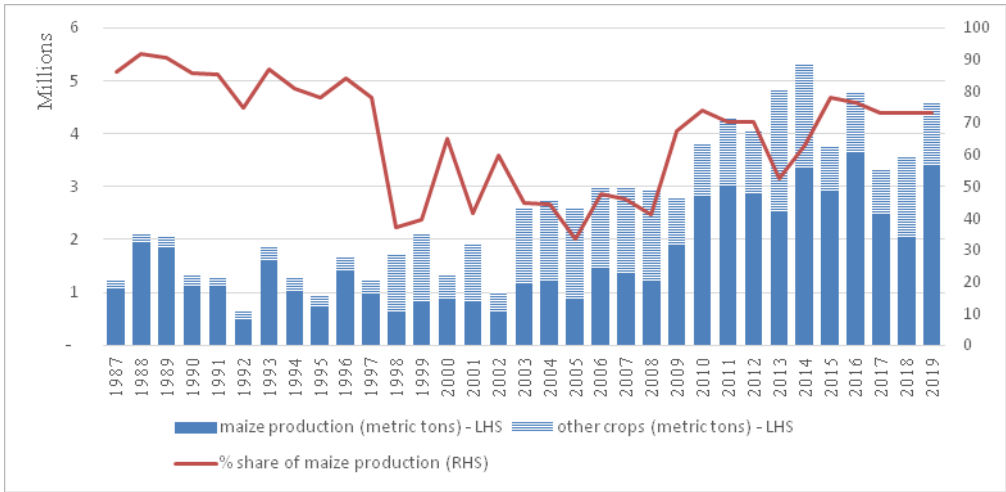
Source: Ministry of Agriculture and Author Computations

Figure 4. Quarterly average rainfall pattern (mm): 1994–2019
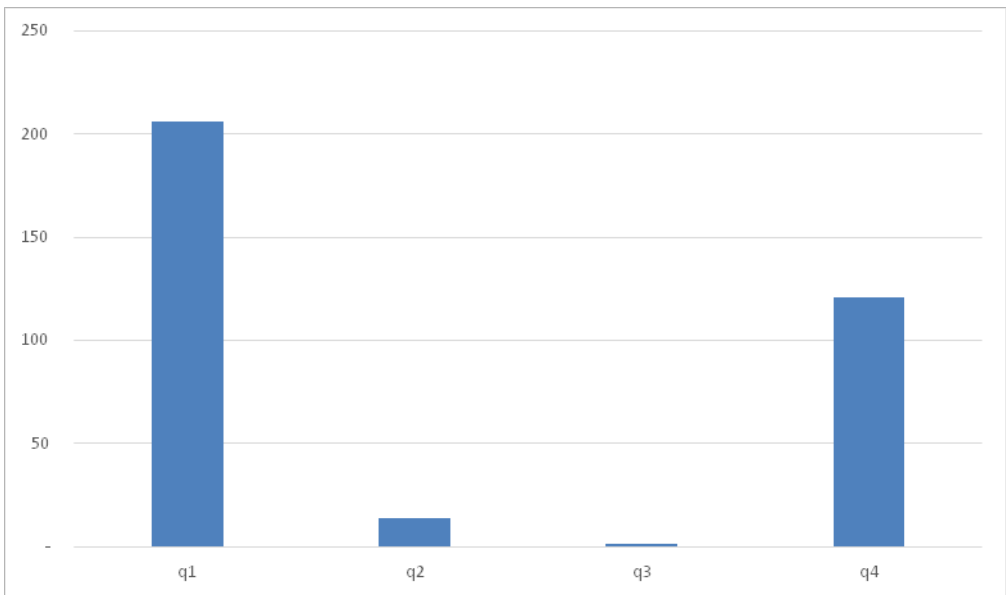
Source: Zambia Meteorological Department and author computations

Due to the dependency on rainfall, maize is grown between December and April (lean period – low supply and high demand). During this period, maize prices are relatively high and only decline in the second and third quarters (harvest period) and are usually at their lowest in the latter quarter (Figure 5). The gradual fall in maize prices from the end of the first quarter, preceding the onset of the marketing period, largely 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 other food items become available. This dampens the price of the staple food through substitution. The variations in maize prices are reflected in food inflation due to the relatively high weight of maize grain and its products in the CPI basket (Annex 2). The total weight of maize as a single product is 64.98[4], representing 11.8% and 6.5% in the food CPI and overall CPI, respectively.

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. Trade in maize is regulated by the government through the issuance of export and import licences. Under this arrangement, the prevailing maize price may not 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.

Figure 5. Trend in monthly average maize price (Kwacha/50kg bag): 1994–2019
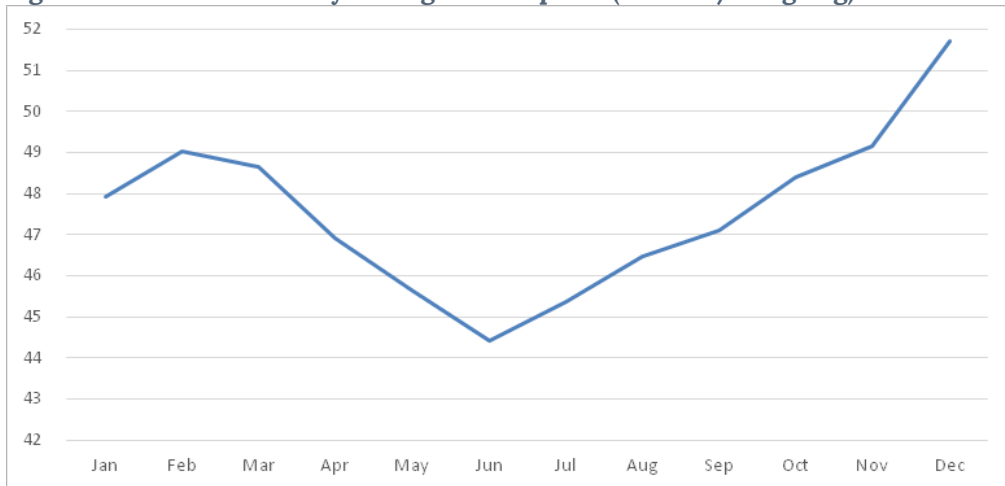
Source: Bank of Zambia and author computations

The significance of external shocks transmitted through the exchange rate and energy (oil) prices on inflation was notable during 2008-2009 and post-2011 periods (Figure 6). The influence of the global financial crisis of 2008/2009 is reflected in higher inflation in 2008 and 2009 through the exchange rate channel as copper prices[5] fell markedly. 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 exchange rate to domestic CPI in developing and emerging market economies that include Zambia. It is noteworthy from Figure 6 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. 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 6. Overall inflation and changes in the exchange rate (%)
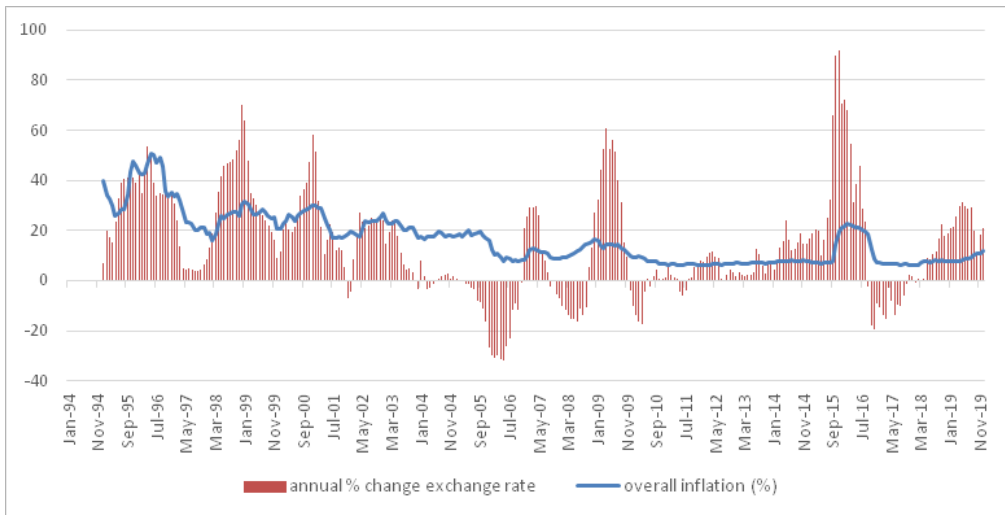
Source: Bank of Zambia and author computations

Note: a positive change in the exchange rate denotes a depreciation and a negative change an appreciation

There are traces of the predicted positive relationship between money supply and inflation with lags in some periods in Figure 7. For example, inflation generally rose when money supply grew steadily from mid-1998 and reached the peak at end-2000. The exception was 1999 when inflation trended down. 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 7. Overall inflation and money supply growth (%)
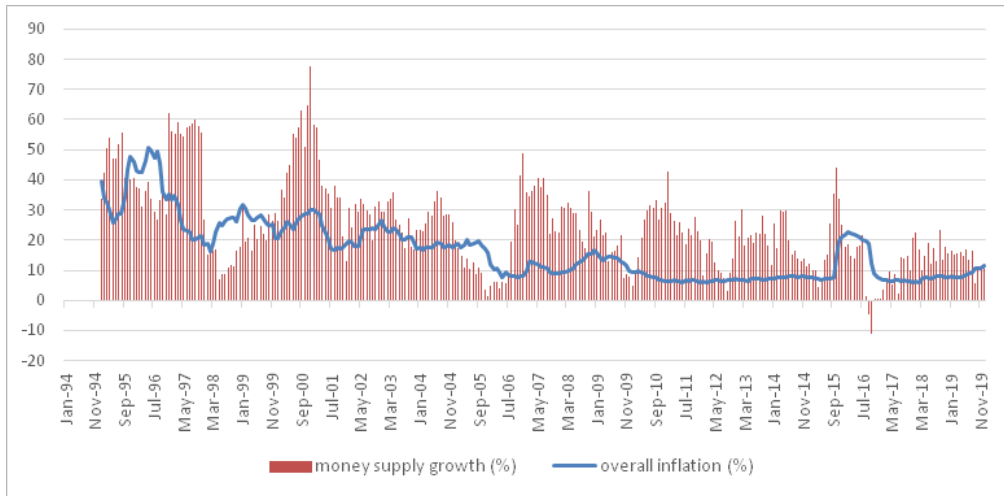
Source: Bank of Zambia and author computations

This brief discussion highlights the importance of various sources of inflation (demand-pull, cost-push, and supply-side factors) 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 are the key models that underlie the explanations for the drivers of inflation.

The monetarists believe that inflation is directly 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 increase in the general price level. To control inflation, a tight monetary policy stance is required to contain aggregate demand.

According to 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 the structuralist theory, supply-side constraints induce excessive growth in real money balances that ultimately leads to inflation. Therefore, inflation is driven by sectoral bottlenecks that 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 the government, and shortages of foreign exchange[6].

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 influence especially in the 70s and 80s before stabilization programmes were adopted and foreign exchange markets were slowly liberalized. This study focuses on empirical evidence on African countries with similar economic characteristics to Zambia in order to draw relevant policy lessons for the latter. Wu (2017) provides numerous studies on the sources of inflation in sub-Saharan Africa that 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). The growth in money supply is also noted to account for a

significant portion of inflation in the short-run in Ethiopia and Uganda. In addition, money supply and interest rates were highlighted as key short-run influences on inflation in Kenya by Durevall and Ndung'u (2001). Further, 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 that the exchange rate is a key driver of inflation in most African countries.

Durevall and Ndung'u (2001) investigated the dynamics of inflation in Kenya over the period 1974-1996 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 shocks. Further, Osei (2015) found inflation to be persistent in Ghana with petroleum prices, and the exchange rate 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 innovations (Mwansa, 1998). The dominance of the exchange rate as a driver of 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 Ghana. In view of this, policymakers were 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 analysing inflation in Tanzania in which multiple single-equation models for headline, food, energy and core inflation were estimated. Supply side factors (that is 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 complimented 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) established 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. In investigating the determinants of inflation in Malawi, Wu (2017) established non-food prices to have a direct impact on headline inflation and also exert a significant impact on food inflation through the second round effects. In view of these results, Dureval et al (2013) recommended the inclusion of world food prices and domestic agricultural production in the study of inflation for economies where the share of food in consumer prices is large.

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 exchange 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 rainfed production practices.

4. Model specification and estimation method

A number of studies have employed a single-equation ECM approach in modelling inflation. These include Diouf (2007), Durevall et al (2013), and Adam et al (2016). Both short-run and long-run determinants of the sub-components of inflation are incorporated in a single-equation inflation model. The long-run determinants are derived from equilibrium relations specified in both money and external markets relations from which the error correction equations are obtained. The short-run determinants include control factors in the long-run equilibrium model for money demand, domestic food prices and non-food prices, including other factors suggested by different theoretical models and empirical literature.

To implement the single-equation ECM, the long-run equilibrium in the money and external (foreign exchange) markets is first estimated using sectoral vector error correction models (VECMs). The error correction terms derived from each market are then incorporated in the overall inflation model that includes the first difference of all the variables used in the long-run equations and other factors that can potentially impact inflation as well as supply-side constraint factors. Deterministic terms are also included in the model specification. The single-equation model is estimated with 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 and purchasing power parity as follows:

$$(m_t - p_t) = \emptyset_1 y_t + \emptyset_2 r_t \tag{1}$$

$$pf_t = s_t + wfp_t \tag{2}$$

$$pnf_t = s_t + wp_t \tag{3}$$

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_t 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 and decrease in the rates of return on alternative assets to m_t (that is foreign bonds, domestic goods, and cash holdings in foreign currencies). In view of this, equation 1 can be expanded as

$$(m_t - p_t) = \emptyset_1 y_t + \emptyset_2 di_t - \emptyset_3 i_t^* + \emptyset_4 \Delta p_t + \emptyset_5 \Delta s_t \qquad (1)$$

where di_t is the own rate of return or deposit rate on m_t; i_t^* is the return on foreign bonds; Δp_t is inflation representing the fall in the demand for Δs_t in preference for domestic goods as the purchasing power of m_t is eroded; and Δs_t is the depreciation of the domesticy currency against foreign currencies that leads to the shift into the holdings of foreign currency denominated assets.

Equations 2 and 3 represent a purchasing power parity (PPP) relationship for the long-run external market equilibrium for 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[7] (τ_t) is usually added to Equations 2 and 3 (Durevall and Ndung'u, 2001; Diouf, 2007) and re-specificied as:

$$pf_t = s_t + wfp_t + \tau_t \qquad (2.1)$$

and expanded as

$$pf_t - s_t - wfp_t = \gamma_0 + \gamma_1 \tau_t + v_t \qquad (2.2)$$

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

and expanded as:

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

where v_t is the error term.

If $\gamma_1 = 0$ and v_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 VECM estimation method is employed to determine the dynamics in food and non-food inflation as follows:

$$\Delta pf_t = \propto_0 + \propto_1 ecm\_rmb_{t-1} + \propto_2 ecm\_pf_{t-1}$$

$$+ \sum_{i=1}^{k1} \propto_{3i} \Delta pf_{t-i} + \sum_{i=1}^{k1} \propto_{4i} \Delta m_{t-i} + \sum_{i=1}^{k1} \propto_{5i} \Delta s_{t-i}$$

$$+ \sum_{i=0}^{k1} \propto_{6i} \Delta wfp_{t-i} + \sum_{i=1}^{k1} \propto_{7i} \Delta pnf_{t-i} + \sum_{i=0}^{k1} \propto_{8i} SC_{t-i} + \sum_{i=1}^{q} \propto_{9i} D_t + \varepsilon_t \tag{4}$$

$$+ \sum_{i=1}^{k1} \propto_{5i} \Delta s_{t-i} + \sum_{i=0}^{k1} \propto_{6i} \Delta wp_{t-i} + \sum_{i=1}^{k1} \propto_{7i} \Delta pf_{t-i} + \sum_{i=0}^{k1} \propto_{8i} ep_{t-i} + \sum_{i=1}^{q} \propto_{9i} D_t + \varepsilon_t \tag{5}$$

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:

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

where SC_t is a measure of supply 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 misspectification.

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 is inevitable 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 the 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). In terms of empirical evidence, 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:

$$\Delta p_t = \propto_0 + \propto_1 ecm\_rmb_{t-1} + \propto_2 ecm\_pf_{t-1} + \propto_3 ecm\_pnf_{t-1} + \sum_{i=1}^{k1} \propto_{4i} \Delta p_{t-i}$$

$$+ \sum_{i=1}^{k1} \propto_{5i} \Delta m_{t-i} + \sum_{i=1}^{k1} \propto_{6i} \Delta s_{t-i} + \sum_{i=0}^{k1} \propto_{7i} \Delta wfp_{t-i} + \sum_{i=0}^{k1} \propto_{8i} \Delta wp_{t-i} + \sum_{i=0}^{k1} \propto_{9i} \Delta ep_{t-i}$$

$$+ \sum_{i=0}^{p} \propto_{10i} SC_{t-i} + \sum_{i=1}^{q} \propto_{11i} D_t + \varepsilon_t \qquad (6)$$

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 positive as excess money balances (latent excess aggregate demand) are supposed to increase inflation in the next quarter. 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 more 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 is the producer price index for South Africa $(ppisa_t)$. The rationale for choosing $ppisa_t$ is due to strong trade links between Zambia and South Africa whereby over 40% of the former's imports (based on data over the sample period) are sourced from the latter. Durevall et al (2013) also used producer prices for the European Union (EU) due to strong trade links between Ethiopia and the EU. Thus, rising costs faced by producers, mostly manufacturers, in South Africa are by and large transmitted to non-food inflation in Zambia via imports due to the high dependence of the latter on the former.

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[8]. Moreover, initial estimates revealed low explanatory power of rainfall with very small coefficient estimates.

6. Empirical results

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 presented in Table 1.

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 underlying each series.

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 $(i - i^*)$ between the 3-month Treasury bill yield rate for Zambia and the US with eight lags chosen based on the modified LR test statistic was estimated. The unrestricted VAR (8) passed the serial correlation, normality and heteroscedasticity misspecification tests[9].

The inclusion of other proxies for the opportunity of holding Kwacha balances (that is 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, statistically insignificant or showed no existence of cointegration relation among variables. Further, tests for weak exogeneity 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.

Table 1: Augmented Dickey–Fuller (ADF) unit root tests

Variables	t-ADF Level	Lags	t-ADF First Difference	Lags	Deterministic 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 (i)	-2.08	5	-5.99***	4	C and T	3-month average Treasury bill yield rate for Zambia
tbrusa (i^*)	-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 the price of grain maize
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

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

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	$i_t - i_t^*$		
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)			
Weak exogeneity test statistics (probability values in square brackets)				
	rmb_t	y_t		$i_t - i_t^*$
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. This in part reflects a high degree of monetisation of the economy over time (Monfort and Peña, 2008). In addition, an increase in the interest rate differential induces demand for money balances as the return on Kwacha denominated assets exceeds similar assets denominated in US dollars, all else being equal. A higher return on domestic bonds relative to US or foreign bonds tends to increase the demand for broad money to facilitate investment in domestic bonds. The capital account in Zambia was liberalized in 1994 and residents are permitted to hold foreign currency accounts, which allows them to substitute domestic assets for foreign assets.

Overall, the demand for broad money in Zambia is determined by income as well as domestic and foreign interest rates, allowing for substitution between domestic and foreign assets when interest rates differ. The error correction term for real money balances is:

$$ecm\_rmb_{t-1} = (m_{t-1} - p_{t-1}) - 2.24 - 1.39y_{t-1} - 0.01(i_{t-1} - i^*_{t-1})$$

Further, the deviations of real money balances from the estimated equilibrium to which domestic prices respond is plotted in Figure 8. The positive values reflect excess money supply or latent excess aggregate demand (Adam et al, 2016). Broadly excess money supply growth reduced drastically from 2016 to nearly 0%. Moreover, excess money supply was very low prior to 2016, below 0.2%, to induce inflationary pressures.

Figure 8 Monetary disequilibrium: 1994–2019
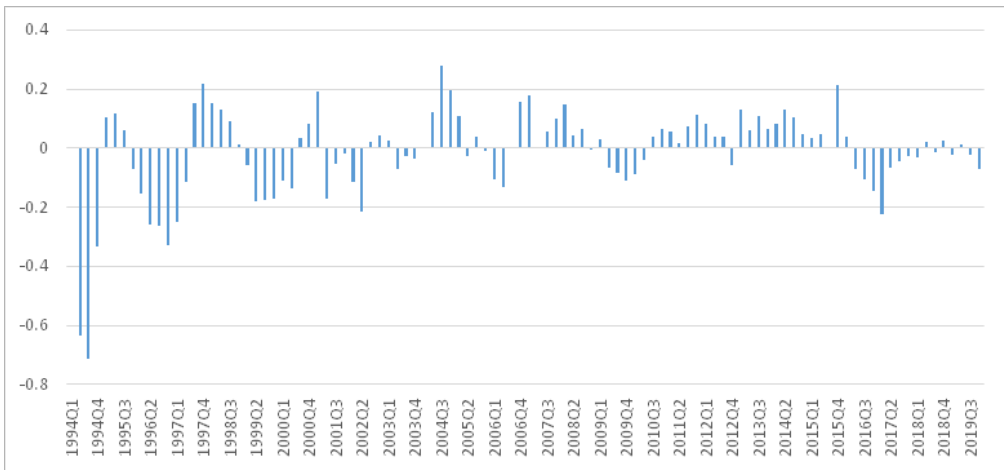
Sources: Author computations

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[10]. The null of no cointegration test was rejected by the trace test and revealed evidence of one cointegrating vector.

The cointegration results analysis for the food PPP relation are reported in Table 3. 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). The associated error correction term is:

$$ecm\_pf_{t-1} = pf_{t-1} + 0.10 - 0.82(s_{t-1} + wfp_{t-1})$$

The weak exogeneity tests 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. The positive influence of world food prices on long-run domestic prices of food in Zambia reflects to a large extent the liberation of the domestic agricultural market. This is despite the government playing a dominant role in the setting of floor maize prices. Exports of maize are regulated by the government through export permits, but the private sector generally considers international prices in the setting of domestic prices due to active cross-border trade with neighbouring countries mostly DRC, Malawi and Zimbabwe.

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)		
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)			
	pf_t	$s_t + wfp_t$	
$\chi^2(1)$	8.4908[0.0036]	2.1994[0.1381]***	

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

Further, as shown in Figure 9, the upward trend in domestic food prices, particularly during the latter part of the sample, were 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 is more pronounced, hence the close link between domestic food inflation and foreign food prices.

Figure 9: Plot of domestic food prices, world food prices and exchange rate
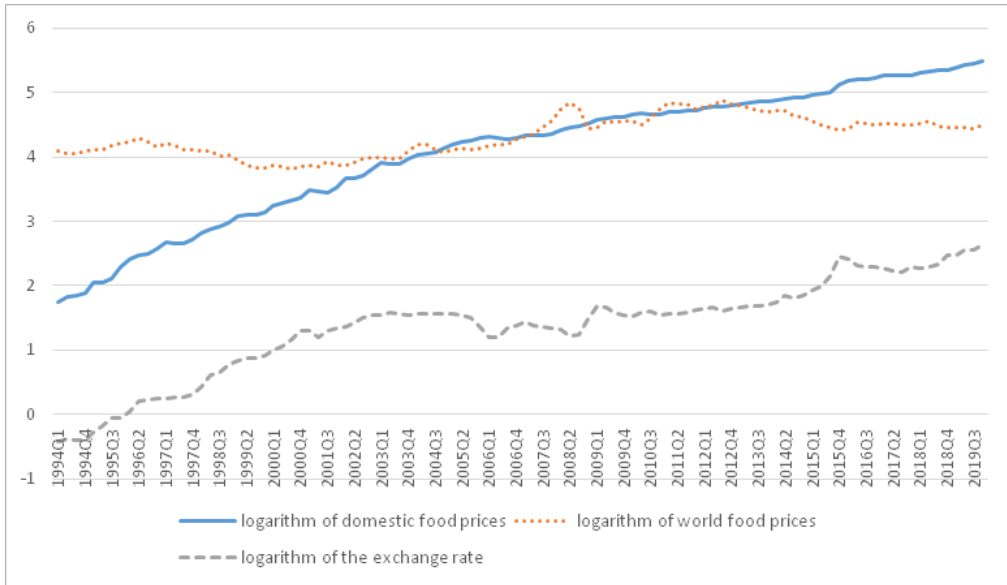
Sources: Author computations

Similar to the food CPI PPP formulation, non-food prices in Zambia are impacted by the exchange rate and world non-food prices (that is producer prices in South Africa) in the long-run and the associated error correction term reported in Table 4 is

$$ecm\_pnf_{t-1} = pnf_{t-1} + 1.91 - 0.39(s_{t-1} + wp_{t-1})$$

These findings are consistent 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. Atta et al (1999) confirmed PPP for Botswana prices and South African prices denominated in Botswana pula, supported by strong trade links between the two countries. Zambia also depends on South Africa for most imports of final consumer and capital goods, and the existence of absolute PPP is not surprising. 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[11]. 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 food prices and a combination of the exchange rate and world food prices (world 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			
Normalized cointegrating coefficients (t-values in parenthesis)			
pnf_t		$s_t + wp_t$	
1.00		-0.39	
		(-4.01)	
Adjustment coefficients (t-values in parenthesis)			
$d(pnf_t)$	-0.03		
	(-5.39)		
$d(s_t + wp_t)$	-0.04		
	(-2.33)		
Unit root test for residuals from the cointegrating Non-Food PPP regression			
ADF test statistic			-10.05***
Critical values from Engle 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)			
	pnf_t	$s_t + wp_t$	
$\chi^2(1)$	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 10 reveals a close upward trend in all the series, hence the cointegration reported in Table 4.

Figure 10: Plot of domestic non-food prices, world non-food prices and exchange rate
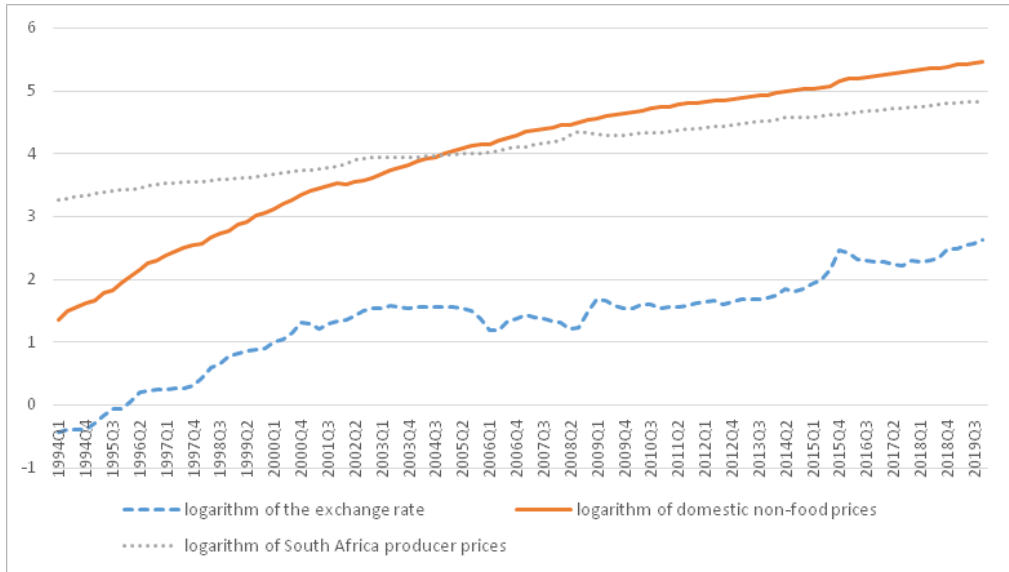
Sources: Author computations

Having established the existence of long-run equilibrium relationships in the money and foreign exchange markets using the Johansen procedure, VECMs for food, non-food, and overall inflation were estimated using the OLS method for the period 1995.2-2019.4. A general-to-specific approach was used to obtain parsimonious results for the three inflation equations reported in Table 5.

Four lags for all the variables in first difference, a constant, as well as seasonal (*D1, D2 and D3*) and impulse (*ID1, ID2 and ID3*) dummies were incorporated in each inflation equation. Impulse dummy *D1* largely reflect variations in food supply (mostly maize) and sharp depreciation of the Kwacha exchange rate; *D2* is largely associated with excessive monetary expansion; and *D3* 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 that is the money demand and corresponding external sector ECM derived above. Lagged values of non-food inflation entered the food inflation equation and vice versa to capture feedback between the two series. The inclusion of impulse dummies helped to eliminate omitted variables and non-normality error tests. However, 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)[12]. 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%. World food prices, producer prices for South Africa, diesel prices, and maize prices, as 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).

Table 5. Parsimonious inflation models

	Food CPI Inflation (Δpf)		Non-Food CPI Inflation (Δpnf)		Overall CPI Inflation (Δp)
	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-1}	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)
ID1	0.058(7.75)	ID2	0.038(4.94)	Δs_{t-2}	0.052(2.34)
ecm_pf$_{t-1}$	-0.035(-4.34)	ecm_pnf$_{t-1}$	-0.018(-6.79)	Δmp_{t-2}	0.026(2.96)
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)

Table 5 Continued

	Food CPI Inflation (Δpf)		**Non-Food CPI Inflation** (Δpnf)		**Overall CPI Inflation** (Δp)
Adjusted R²	0.7576	*Adjusted R²*	0.7735	*Adjusted R²*	0.8171
LM test	F(2,88)=1.2029 [0.3052]	LM test	F(2,91)=0.9642 [0.3851]	LM test	F(2,77)=0.2352 [0.7910]
ARCH	F(1,96)=1.1770 [0.2807]	ARCH	F(1,99)=0.2306 [0.6321]	ARCH	F(1,96)=3.13e-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 1995.1, 1995.4, 1996.1, 1997.1, 1998.1, 2000.1, 2001.1, 2002.1, 2002.4, and 20015.4; ID2 is an impulse dummy capturing spikes in non-food CPI inflation in 1994.2, 1995.2, 1995.4, 1996.2, and 1999.1; ID3 is an impulse dummy capturing spikes in overall CPI inflation in 1995.1, 1995.4, 1996.1, and 20015.4.

The drivers of domestic food inflation in the short-run are changes in the exchange rate and supply constraints (maize prices). Changes in the exchange rate affect domestic food inflation with a one-quarter lag and its impact is larger than that of maize prices. A 1% increase in the change of exchange rate leads to a 0.08% rise in domestic 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. In addition, food inflation tends to be lower in the second and third quarters, largely reflecting the increase in food supply, especially maize (staple food), when the harvest period commences. The strong influence of seasonality in food inflation is similar to the findings by Adam et al (2016) for Tanzania which is replicated in overall inflation. Further, the spikes captured in the impulse dummy raised food inflation over the sample period. Apparently, there is absence of persistence in food inflation as none of the lagged values of food inflation is statistically significant. Adam et al (2016) found very little evidence of persistence in food price inflation in Tanzania where the lagged coefficients at lags two and four cancelled out. Further, the error correction term for the external food sector is statistically significant with the expected sign while that for the money market is insignificant despite having the expected sign. This empirical result implies that, in the long-run, domestic food prices are driven by the exchange rate and world food prices: a 1% increase in world food prices, expressed in Kwacha, lead to a 0.82% rise in domestic food prices. However, the adjustment to disequilibrium in the external market is slow, at about 3.5% per quarter, and the burden of adjustment is borne by domestic food prices as foreign prices are weakly exogenous (Table 3).

Similar to the food inflation, the money market error correction term is statistically insignificant 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: a 1% increase in producer prices in South Africa leads to a 0.39% rise in non-food prices. 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 appears 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 could be heavily influenced by the Kwacha exchange rate as the exchange rate is generally an endogenous variable that adjusts instantaneously to eliminate imbalances after a shock.

In the short run, non-food inflation is driven by the growth in money supply as well as changes in the exchange rate and diesel (energy) prices. In addition, feedback from food inflation 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 raised non-food inflation over the sample period. The results imply that a 1% depreciation in the Kwacha/US dollar 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. Changes 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%. The lagged effect of energy prices on non-food inflation occur after one quarter with an impact of about 0.04%. There is no seasonal in non-food inflation similar to the findings by Adam et al (2016) for Tanzania.

Consistent with the food and non-food inflation, the money market error correction term is statistically insignificant in the overall inflation equation despite having the expected sign. In addition, the error correction term for food prices is insignificant and bears the unexpected sign. Thus, the statistical significance of the non-food error correction term implies that overall domestic prices are determined by the exchange rate and world non-food prices 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, and therefore 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.

Further, overall inflation displays seasonality, underpinned by the behaviour of food CPI inflation due to the relatively larger weight of the latter in the overall CPI basket. Inflation is on average lower in the third quarter, coinciding with the on-set of the agricultural marketing season for maize[13], and higher in the first quarter - "lean" period. The spikes captured in the impulse dummy raised overall inflation over the sample period. The empirical results reveal inertia in overall inflation, but the size of the coefficients are 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 movements in the exchange rate, adjustments in energy (diesel) prices, imported inflation (from South Africa), and supply constraints (changes in maize prices). The coefficient for growth in money supply 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. Changes 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 overall 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 positive.

A notable observation from the empirical results is that money did not appear to have long-run influence on prices in Zambia over the sample period. However, the growth in money supply had short-run effects only on non-food inflation. This result is similar to Kenya, Chad and Ethiopia as reported by Durevall and Ndung'u (2001), Kinda (2011), and Durevall et al (2013), respectively. However, 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. The most plausible reason for the weak impact of money supply growth on overall inflation is the prevalence of excess liquidity in the banking system which tends to disrupt and induce instability in the relationship between base money and broad money[14]. This ultimately affects the transmission mechanism of monetary policy. The banking system in Zambia was characterized by excess liquidity induced by excess Government spending over the sample period (Bank of Zambia Annual Reports, 1994-2019). Simpasa et al (2014) provided evidence of a weakening link between money supply and inflation based on a volatile and declining velocity of money accompanied by rising money multiplier. This contributed to the observed inverse relationship between broad money growth and inflation. This evidence could have influenced the central bank in abandoning the monetary targeting regime in preference for interest rate regime in order to improve the signals for the stance monetary policy through interest rate adjustments.

7. Conclusion

This study assessed the underlying empirical drivers of inflation in Zambia over the period 1994.1-2019.4. Monetary and external factors as well as supply constraints were considered. A single-error correction model was adopted 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 world non-food prices drive domestic prices. In the short-run, overall inflation is influenced by movements in the exchange rate, adjustments in energy (diesel) prices, imported inflation (from South Africa), and supply constraints (changes in maize prices). In addition, overall inflation exhibits persistence and seasonality. Further, 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 behaviours. While inertia is absence 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. The absence of inertia in food inflation is similar to the findings by Durevall et al (2013) for Ethiopia. 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 changes in the exchange rate and supply constraints (maize prices). In the case of non-food inflation, the growth in money supply as well as changes in the exchange rate and 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 highlight the role for the authorities to manage demand-side factors reflecting a combination of both demand and cost-push factors. Specifically, 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 undertake policy actions to dampen excessive depreciation of the Kwacha. In addition, the significance of imported inflation from

South Africa calls for policies to expand and diversify the manufacturing base in order to limit the current high dependence on South Africa for imports of final consumer and capital goods. The data from January to April 2018 show that 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 will be immediately transmitted to Zambia.

The role of supply shocks evident in the impact of maize prices on inflation calls for significant reforms in the agriculture sector to boost productivity through the use of modern techniques such as irrigation to reduce dependence on rainfed practices. In addition, better use of fertilizer, improved seed and access to credit especially among poor rural households will 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 will moderate agricultural product prices and ultimately stabilize inflation.

Notes

1. To eliminate the parallel market for foreign exchange which had emerged during the fixed regime, improve the allocation of foreign exchange previously allocated 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 reinstated after the Kwacha lost over 530% of its value against the US dollar over a 16-month period.

2. The sharp depreciation of the Kwacha was mainly driven by higher than programmed fiscal deficit, falling copper prices due to slower-than-expected growth in China, widening current account deficit, and the strengthening of the US dollar.

3. Besides the weather, maize output is affected by fertilizer use and seed variety.

4. 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. 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.

6. 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; the government prints money to invest in infrastructure which in turn generates inflationary pressures in an attempt to boost capital formation to support growth; and the government devalues the document currency to encourage exports, which in turn raises domestic prices and subsequently lead to inflation.

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

8. 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.

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

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

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

12.   Adam et al (2016) found errors to be non-normal in energy, core and headline inflation equation and attributed this to extreme values across the sample.

13.   Maize has a relatively larger weight in the food CPI basket (Annex 2).

14.   Prior to April 2012, the central bank employed a monetary aggregate targeting framework. In this framework, base money was the operating target while broad money was the intermediate target, with inflation as the ultimate objective. The underlying assumption in this framework is that the velocity of money is constant, the relationship between base money and the multiplier is stable, and in turn broad money bears a stable and predictable relationship with inflation. In this regard, deviations of base money from the target are offset by corresponding open market operations.

15.   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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Annex

Annex 1.

CPI main groups (2009 Base Year)	Weight		CPI main groups (1994 Base Year)	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[15]	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: CSO, Prices Statistics, 2014

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