# Assessing Money Supply, Exchange Rate and Inflation Dynamics in Zimbabwe

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**Abstract:** This paper assesses the money supply, exchange rate and inflation dynamics in Zimbabwe using monthly data from December 2009 to December 2018, a period when the country was dollarised. The paper first applies a multivariate regression model to check for the significance of the independent variables. The multivariate regression model established that money supply and the parallel exchange rate premium have some significant influence on inflation in Zimbabwe. To eliminate the endogeniety problem associated with the model and also to allow for the feedback mechanism in the model, the paper applies a Vector Error Correction Model (VECM). The results from the Johansen cointegration tests indicated that the variables were cointegrated thus making it possible to apply the VECM. The VECM established that there is a long-run causality running from the money supply, parallel market exchange rate premium, output gap and inflation as well as short-run causality running from money supply and the parallel exchange rate premium to inflation. A monetary targeting framework is therefore recommended to attain long-run macroeconomic stability.

**Keywords:** Inflation, Potential Output, Output gap, Error Correction Model, Zimbabwe

## 1. Introduction

Inflation occupies a special place in macroeconomic literature. The study of inflation has given rise to some of the most significant macroeconomic debates in the field of economics. One of the major debates arose from the episode of stagflation experienced in the United Kingdom in the 1970s in which unemployment and inflation increased simultaneously, thus proving wrong the long held view of a stable inverse relationship between inflation and unemployment. This gave rise to a host of competing explanations on the possible causes of inflation. Today a variety of issues relating to the causes, transmission, and control of inflation are still being debated. Central Banks across the world have also assumed the mandate of maintaining price stability (low and stable inflation) given the potential repercussions of macroeconomic instability in any economy, including eroding the value of people's wealth and creating uncertainty in the economy.

In Zimbabwe, inflation has been a topical issue from the 1990s when the country adopted an International Monetary Fund (IMF) supported Economic Structural Adjustment Programme (ESAP) which advocated for economic liberalisation, restructuring and dismantling of price controls. The programme culminated in soaring inflation, thus compelling the Government to reintroduce price controls to contain the inflation scourge. After abandoning the ESAP in 1995, inflation continued to pose challenges in the economy as Government printed money to cater for the war veteran's gratuities in 1997 and the subsequent intervention in the Democratic Republic of the Congo (DRC) war in 1998.

Zimbabwe's worst inflation nightmare came during the period from the year 2000 to 2008 when Government embarked on a comprehensive fast track land reform programme which was associated with political violence that led to disruption of farming operations. The fast track land reform programme culminated in the collapse of the agriculture output, thus plunging the economy into a crisis. Food prices went up and the country began to rely more on imported products thus causing acute foreign currency shortage in the economy. As a result, the government failed to honour the international payment obligations leading to the subsequent suspension of the country from accessing foreign funding from the multilateral lending institutions and the Paris Club countries. Against this background, the government resorted to printing of money to finance its budget deficits in light of the drying up of international financing coupled with reduced revenues due to collapsing economic output. The

resultant increase in money supply growth caused inflation to escalate reaching hyper-inflation levels from 2007 and 2008. The domestic currency lost value, thus compelling economic agents to abandonment it in favour of stronger currencies such as the US dollar and the South African rand.

Although inflation stabilised when the country officially dollarised in February 2009, the era of stability was, however, short lived as inflation began to escalate again in the last quarter of 2018, thus rekindling the debate on the causes of inflation in Zimbabwe. Whilst the causes of inflation may be known in theory, in Zimbabwe the causes of inflation are still a hotly debated issue. Moreover, it is not easy in practice to decompose the observed inflation trends into its various components in terms of money supply, exchange rate, demand, cost-push, the self-feeding component of present and past inflation and structural issues in the economy as the process is dynamic and the shocks to prices tend to be mixed-up.

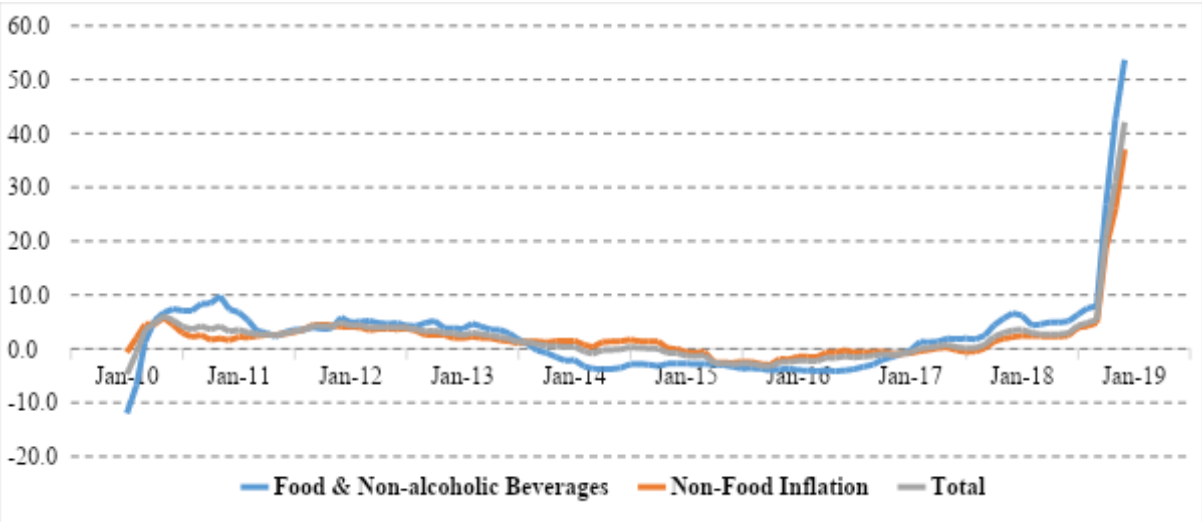
The purpose of this paper is, therefore, to determine the main drivers of inflation in Zimbabwe from 2009 to 2018. The contribution of the paper is to add to the empirical literature on the inflation dynamics in Zimbabwe. Whilst there are some studies which have looked at determinants of inflation, the novelty of this paper is mainly on the approach which is different from previous researches. The rest of the paper is organised as follows: Section 2 presents stylized facts on inflation developments in Zimbabwe, Section 3 reviews the theoretical and empirical literature on inflation, Section 4 describes the methodology used in the study, Section 5 provides empirical analysis of the results and Section 6 concludes the study.

## 2. Stylized facts on inflation in Zimbabwe

Following a hyper-inflation episode experienced from 2007 and 2008 driven by unfettered money supply growth, Zimbabwe's inflation pressures disappeared when the economy became dollarised in 2009. Under the phase of dollarisation, monetary authorities stopped issuing domestic currency and money supply growth became a function of the country's ability to generate foreign currency earnings from exports of goods and services, capital flows in the form of foreign investments and offshore loans and remittances from people in the diaspora. However, due to the poor international credit rating, the government was unable to attract new capital into the country while foreign direct investment was subdued on account of the unfavourable macroeconomic environment in the country. As a result, the country faced some liquidity challenges which depressed aggregate demand, thus leading to deflation from 2013 to 2016.

Nonetheless, the government's continued profligacy resulted in increased domestic borrowing from the central bank leading to increased money supply growth in the economy which was not commensurate with the level of economic activity, thus causing a build-up of inflation pressures in the economy. Foreign currency became scarce and a parallel market for foreign currency re-emerged. Figure 1 shows the inflation trends in Zimbabwe.

**Figure 1: Inflation Developments**

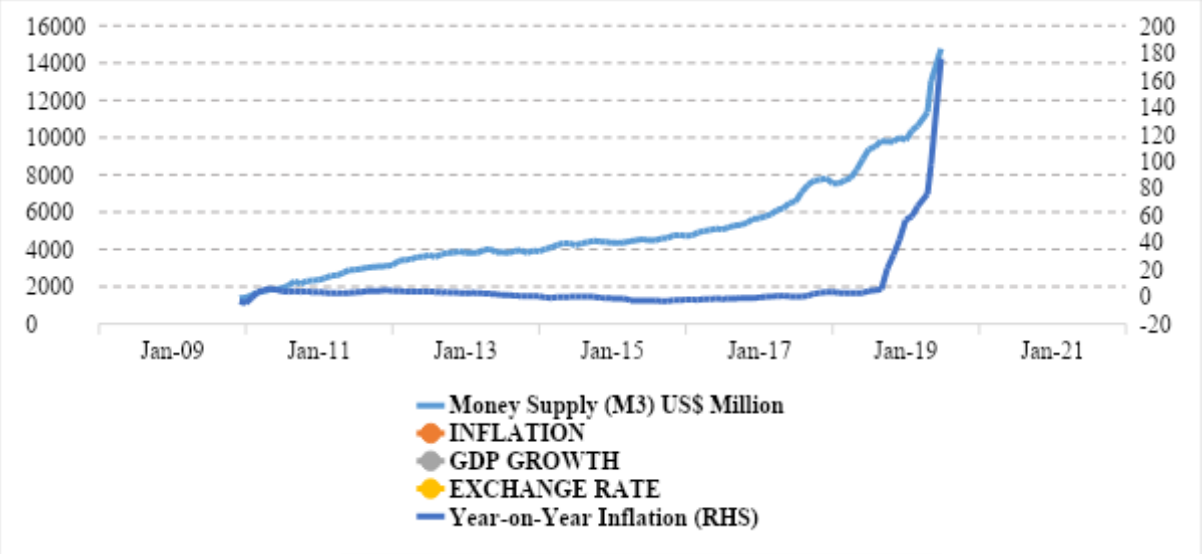



Source: Zimbabwe Statistics Agency (ZIMSTAT), June 2019

As can be seen in Figure 1, Zimbabwe's inflation has been very low from 2009 to 2017 due to depressed aggregate demand. Depressed aggregate demand is believed to have been the main cause for deflation experienced from November 2014 to January 2017. However, from 2017, the country started to experience a positive inflation trajectory as the foreign currency shortages intensified and parallel market premium increased on account of rising fiscal deficits which pushed up money supply growth. From the last quarter of 2018, Zimbabwe's inflation spiked from about 5.39 percent in September to 20.9 in October as the parallel exchange rate depreciated sharply from about 65 percent in August to 700 percent in October. Inflation continued to rise ending the year at 42.1 percent. From 2019, there was growing concern that the spiralling inflation might soon turn into hyper-inflation as the month on month inflation reached a peak of 39.4 percent while the year-on-year inflation reached a peak of 175.6 percent in June 2019. The food sector led the increase compared to the non-food category. This may be due to the fact that the non-food sector was experiencing depressed demand as incomes had not fully adjusted to the prevailing inflation levels.

Money supply growth continued expanding mainly driven by Government borrowing to sustain the ballooning fiscal expenditures. Whilst the country was still dollarised, during the period from 2009 to 2018, the creation of balances on the Real Time Gross Settlement System (RTGS) platform by the central bank which were not backed by foreign currency deposits to finance fiscal deficits led to increased money supply growth which ended up chasing the few US dollars in the economy. The central bank also introduced bond notes in November 2016 as an export incentive to enhance foreign currency generation in the economy. However, the issuance of bond notes exacerbated growth of money supply leading to additional inflationary pressures in the economy. Figure 2 shows the inflation and money supply developments in Zimbabwe from 2009 to 2018.

**Figure 2. Money Supply and Inflation Trends**

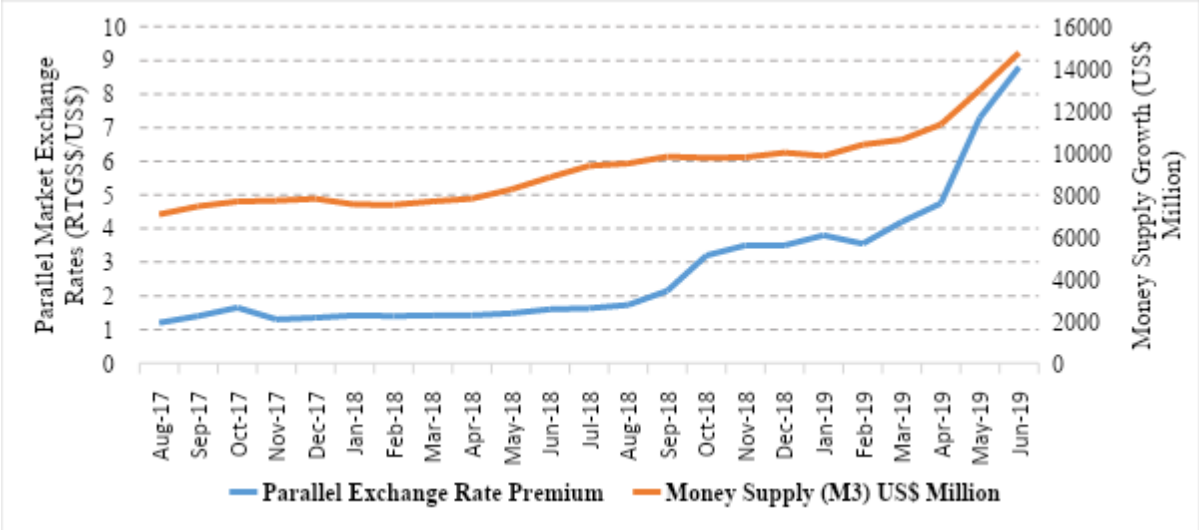



Source: Reserve Bank of Zimbabwe & ZIMSTAT, 2019

Figure 2 indicates that money supply and the year-on-year inflation appeared to move hand in hand, implying that money supply could be one of the drivers of inflation in Zimbabwe. Money supply growth was very high from 2016 but inflation started escalating in the later part of 2018, implying that money supply growth has a lagged effect on inflation.

Money supply growth was also believed to be the main driver of the parallel market premium as the parallel exchange rate movements reflected the money supply trends in the economy. Economic agents and businesses attributed the exchange rate movements to money supply growth. As a result, money supply and parallel market rates depicted some co-movements as shown in Figure 3.

**Figure 3: Money Supply and Exchange Rate Developments**

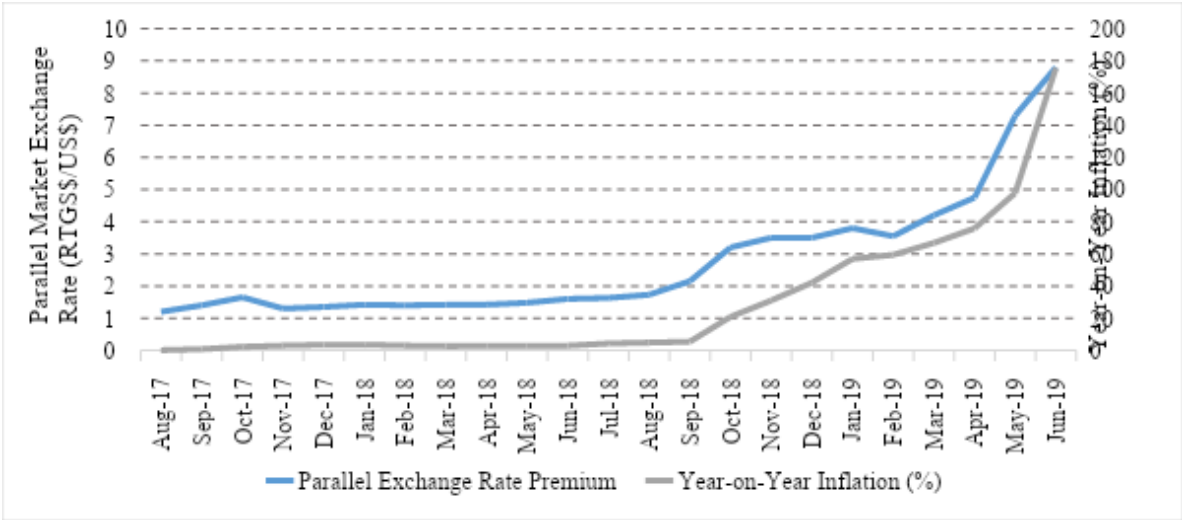



Source: Reserve Bank, 2019

Figure 3 indicates that money supply and the parallel market exchange rate premium exhibited some co-movements from 2017 to June 2019, implying that there was some causality between the two variables.

Although the country moved away from dollarisation in June 2019, when government abandoned the multiple currency system, prices in the country continued to be indexed against exchange rate movements as can be shown in Figure 4.

**Figure 4: Exchange Rate and Inflation Trends**




Source: Reserve Bank & ZIMSTAT, 2019

Figure 4 indicates that the parallel market premiums and inflation had some co-movements in Zimbabwe from 2017 to 2019. This implies that prices in RTGS dollars were being indexed to the US dollar prices since 2017, when the country started experiencing foreign currency shortages.

Nonetheless, there are also other factors that were believed to be behind the inflationary pressures in the economy, notably the adverse inflation expectations emanating from a confidence crisis that had engulfed the economy as well as political instability and slow pace of reforms by the new government which was also causing uncertainty in the economy and forcing people to believe that the economy was sliding back into hyper-inflation.

## 3. Literature

One of the early theoretical strands of literature on inflation was the quantity theory of money which dates back to the mid-16th century when the French social philosopher Jean Bodin first attributed the price inflation in Western Europe to the abundance of monetary metals imported from the mines of the Spanish colonies in South America (Humphrey, 1974). From that time on, the theory began to be measured against empirical findings leading to its refinements and modification overtime until it became fully integrated into the mainstream of orthodox monetary economics. Today the quantity theory of money stands as the oldest surviving economic doctrines. The theory states that the general price level of goods and services is directly proportional to the amount of money in circulation (Friedman, 1987). This gave rise to the Monetarist school which follow Milton Friedman's argument that money supply has more influence on national output in the short run and on price levels in the long-run. Thus monetary policy is seen by the monetarists as a more potent instrument than fiscal policy in promoting economic stability.

The monetarist view also gave rise to a new debate on the importance of money supply in the economy. For instance, the theory attracted criticism from the Keynesian school which argued that aggregate demand comprising of consumption, investment and government expenditure was the main source of demand-pull inflation. The Keynesian theory on the other hand, postulated that money supply had an influence on inflation in a much more complex way than what the strict monetarists suggested, through demand outstripping supply and pulling inflation higher, inflation being built into the system, and by higher costs pushing up prices and leading to even higher inflation (Comley, 2015).

According to the Keynesian theory, changes in aggregate demand, whether anticipated or unanticipated, have their greatest short-run effect on real output and employment, not on prices. Prices and wages respond slowly to changes in supply and demand shocks, resulting in periodic shortages and surpluses, especially of labour (Jahan, et al., 2014). Although the Keynesian theory seems to be more plausible in terms of identification of the relevant variables that describe changes in inflation in the modern day world, it does not provide any measure of the relative importance of the factors involved. As a result, the debate on inflation has been sustained to this date.
There is also the Structural theory of inflation which argues that the aggregate demand-supply model cannot explain inflation in the developing countries because of lack of balanced integrated structure in the economies which make it difficult to substitute between consumption and production and flows of resources between different sectors of the economy (Totonchi, 2011). Thus, it has been argued that economies of the developing countries are structurally underdeveloped as well as highly fragmented due to the existence of market imperfections and structural rigidities of various types which result in shortages of supply relative to demand in some sectors whilst there is under-utilisation of resources and excess capacity in other sectors.

There is also another theory that has emerged in the last three decades, namely the new neoclassical synthesis. The new neoclassical synthesis incorporates both the new classical and new Keynesian elements and somehow solves the dichotomy between the two theories on the origins of business cycles and price formations (Goodfriend & King, 1997). The new neoclassical synthesis model thus allow the Keynesian and real business cycle mechanisms to operate through somewhat different channels which can be explained by the so-called new IS-LM-PC model where the price level is treated as an endogenous variable (Totonchi, 2011). The IS denotes the investment and saving equilibrium equation of the commodity market, LM denotes the demand for and supply of money equilibrium equation of the money market and PC is the Philips curve. Expectations are viewed as critical to the inflation process such that the aggregate supply and Phillips curve component of the model relates inflation today to expected future inflation and output gap (Goodfriend & King, 1997).

Notwithstanding some theoretical differences regarding the specific causes and channels through which inflation is propagated in an economy, it is generally accepted that inflation comes from three main primary causes, namely excess aggregate demand over supply for overheated economies at full-employment of productive resources, the cost-push factors emanating from rising unit labour cost, increased prices of imported intermediate inputs, or supply bottlenecks, and a self-feeding component of present and past inflation arising from adverse expectations. However, the challenge is on how to determine the weighted combination of these three central variables to fully understand the inflation dynamics in an economy.

Various studies have applied different methodologies and come up with different results. Alam & Alam (2016) examined the short-run and long-run sources of inflation in India using the co-integration method developed by Pesaran et al. (2000). Their findings suggest that in the long-run money supply (MS), depreciation of the rupee and supply bottlenecks cause inflationary pressures in the country both in the short-run and long-run. Lim & Sek (2015) examined factors affecting inflation in two groups of countries, namely the high and low inflation countries using annual data from 1970 to 2011. An Error Correction Model based on the Autoregressive Distributed Lag (ARDL) modelling was applied to determine the short-run and long-run impacts of each variable on inflation. The results established that economic growth and commodity imports had significant long run impact on inflation in low inflation countries. The results also established that money supply, national expenditure and economic growth were significant determinants of inflation in the long-run in high inflation countries. None of the variables were significant determinants of inflation in the short-run in high inflation countries.

Anderson et al (2009) also analysed the determinants of inflation differentials and price levels across the euro area countries using the dynamic panel estimation from 1999 to 2006. The results indicated that inflation differentials were primarily determined by cyclical positions and inflation persistence. The persistence in inflation differentials were partly due to administered prices and market regulations.

Nguyen et al (2015) studied the main drivers of inflation dynamics in Sub-Saharan Africa (SSA) using a Global VAR model, which incorporates trade and financial linkages among economies, as well as the role of regional and global demand and inflationary spillovers. The study found that in the past 25 years, the main drivers of inflation have been domestic supply shocks and shocks to exchange rate and monetary variables although the contributions of the shocks were falling with time. In addition, the domestic demand pressures and shocks to output had a significant influence on inflation. The extent of oil and food imports, vulnerability to weather shocks, economic importance of agriculture, trade openness and policy regime, among others had a bearing on the extent of the impact. The above empirical analysis indicates that the factors may be common in most countries but the extend of each respective variable differs depending on the country situation.

## 4. Model Specification

From the theoretical literature, it was observed that most traditional theories of inflation emphasise the importance of money supply, aggregate demand, unemployment and supply shocks as the main determinants of inflation. The structuralist model on the other hand incorporated a new dimension on the importance of expectations, the role played by political developments, export performance, import prices, agricultural bottlenecks and availability of foreign reserves (Akinbobola, 2012). As such, the structural model provides a good proxy of inflation dynamics particularly in developing countries which still have imperfect markets.

In this study, we develop A Vector Error Correction Model (VECM) to assess the money supply, exchange rate and inflation dynamics in Zimbabwe. This is because of the importance of the additional factors in explaining inflation dynamics in Zimbabwe. This model builds on the following regression model:

$$P = f\left(BD, EXR, P^{m}, Y, EB, \pi^{e}, PS\right) \quad (1)$$

Where P is inflation, BD is the budget deficit, $P^{m}$ is the price of imports, EB is the external balance, $\pi^{e}$ is the inflation expectations and PS is political stability. Since money supply growth in Zimbabwe is linked to the budget deficit, the budget deficit is therefore replaced with money supply growth. Inflation expectation is determined by changes in previous inflation trends. When inflation is rising, economic agents believe that the trend will continue in the future, such that the expected rate of inflation becomes self-feeding such that it can be explained by its past trends ($P_{t-1}$).

It is also assumed that political stability is already captured by the trend in the economic activity and inflation developments, such that it can be dropped in the final model representation. The price of imports is also directly related to the exchange rate in that when foreign prices are high, there will be expenditure switching as foreign goods are replaced with domestic goods thus reducing the current account deficit or causing the exchange rate to appreciate. Similarly, when foreign prices are low, the demand for imports rises and more money goes out to purchase imports leading to a depreciation in the exchange rate. Moreover, the external sector balance affects the

country's international reserve position and has a direct influence on the exchange rate. In view of this, it is assumed the exchange rate already takes care of the foreign prices and therefore $P^f$ is also dropped since the exchange rate fully captures the influence of the external balance on inflation developments in the country. This leads to a parsimonious model which can thus be represented as follows:

$$P = f\left(MS, EXR, P^f, Y, P_{t-1}\right); \quad f(MS) > 0,\ f(EXR) > 0,\ f(P^f) > 0,\ f(P_{t-1}) > 0 \tag{2}$$

Where P is the year-on-year inflation, MS is money supply, EXR is the parallel market premium and Y is the output gap.

Sequel to this, the final model is as follows:

$$\ln P_t = \alpha + \beta_1 \ln(P_{t-1}) + \beta_2 \ln(MS_t) + \beta_3 \ln(EXR_t) + \beta_4 \ln(Y_t) + \varepsilon_t \tag{3}$$

Where $\beta$ is the coefficient for the respective variables, and $t$ is the time factor and $\varepsilon$ is the error term.

The output gap is the difference between actual output and the potential output. The potential output can be regarded as the level of GDP attainable when an economy is operating at a high rate of resource use, or as a summary measure of an economy's productive capacity. Estimating potential output removes fluctuations emanating from business cycles and establishes an underlying trend in GDP. Potential output is estimated using the using the Hodrick-Prescott (HP) Filter. The HP Filter is a procedure of estimating potential output, based on a statistical smoothing process. The method estimates the level of potential output, by fitting a trend line that minimises the difference between actual output and potential output while at the same time imposing limits on variations in growth of potential output. Potential output is generally calculated as:

$$\left(\frac{Y_t - Y_t^{pot}}{Y_t^{pot}}\right) \tag{4}$$

Where

$$\ln\left(Y_t\right) - \ln\left(Y_t^{pot}\right) = y_t - y_t^{pot}$$ and *pot* denote the potential output (5)

### 4.1 The Vector Error Correction Estimation (VECM)

Since the variable of interest are simultaneously related, there is need to treat each variable symmetrically to allow for a feedback mechanism. The advantage of a VECM is that it allows for interpretation of both the long-run and short-run equations. This requires testing of the variables to check if they are stationary or integrated of order 0, that is I (0). If they not I (0), it is assumed that the variables have a unit root or are integrated of order 1, that is I (1). If a set of variables are all I (1) they should not be estimated using ordinary regression analysis, but between them there may be one or more equilibrium relationships. We can therefore estimate how many cointegrating vectors using the Johansen's technique.

### 4.2 Data

The study analysed monthly data from December 2009 to December 2018. The data on inflation and GDP growth was obtained from the Zimbabwe Statistics Agency (ZIMSTAT). The data on money supply and parallel market exchange rate premium was obtained from the Reserve Bank of Zimbabwe. In estimating the model, all the variables were tested for stationarity using the Augmented Dickey-Fuller test. As for the optimal lag length, the tests were based on the Final Prediction Error (FPE), Akaike Information Criteria (AIC), Schwartz Bayesian criterion (BIC) and Hannan-Quinn criterion (HQC).

## 5. Empirical analysis

The variables were first tested for stationarity using the Augmented Dicky-Fuller (ADF) test. Results of the unit root tests are as indicated in Table 1. The results indicate that all variables appear to be stationary after first differencing.

**Table 1: ADF Unit Root Test Results**

| Variable | Levels | 2nd Difference |
|---|---|---|
| Inflation (INFLN) | -1.187911<br>(0.1666) | -4.182791***<br>(0.0066) |
| Money Supply (MS) | 0.805519<br>(0.9997) | -7.539983***<br>(0.0000) |
| Parallel Market Exchange Rate Premium (PEXRP) | 2.176978<br>(1.0000) | -7.518248***<br>(0.0000) |
| Output Gap (YGAP) | -2.850550<br>(0.1830) | -10.33912<br>(0.0000)*** |

Source: Researcher's own computations. Figures in parenthesis are probabilities found from the critical values by MacKinnon (1996) Maximum lag length; *indicates stationarity at 10%, ** indicates stationarity at 5%, *** indicates stationarity at 1%.

The optimal lag criteria were also determined using the Final Prediction Error (FPE), Akaike Information Criteria (AIC), Schwartz Bayesian criterion (BIC) and Hannan-Quinn criterion (HQC) which all indicated an optimal lag of 2.

The multivariate regression model was also used to check for the significance of the money supply, parallel market exchange rate premium and output gap in influencing inflation dynamics in Zimbabwe. The results of the multivariate regression model as indicated in Table 2.

**Table 2: Multivariate Regression Model Results**

| Variable | Coefficient | Std. Error | t-Statistic | P- Value |
|---|---|---|---|---|
| **C** | 9.171594 | 2.718680 | 3.373547 | (0.0010)*** |
| **INFLN (-1)** | 0.675643 | 0.060701 | 11.13069 | (0.0000)*** |
| **LOG(MS)** | 7.420124 | 2.422221 | -3.063356 | (0.0028)*** |
| **LOG(PEXRP)** | 2.085853 | 0.556101 | 3.750850 | (0.0003)*** |
| **LOG(YGAP)** | 0.132800 | 0.117671 | 1.128569 | (0.2617) |

In terms of the results from the multivariate regression model, both money supply and the exchange rate had a positive and significant relationship with inflation in Zimbabwe. The past inflation developments as shown by the lagged inflation were also very significant implying that past inflation in Zimbabwe was causing inflation. This implies that inflation had gained some inertia particularly in 2018 due to adverse expectations as business confidence levels declined. However, the output gap did not have a significant influence on inflation in Zimbabwe.

One of the limitations of the multivariate regression model is that the principal variables of interest, notably inflation, exchange rate and money supply growth are potentially endogenous variables. To eliminate the endogeniety problem and to allow for the feedback mechanism in the model, the Vector Error Correction Model (VECM) was used to analyse the response of inflation to shocks in the other variables and to determine the short and long-run relationship between the variables. This requires to first determine if the variables of interest are cointegrated or not. When the variables are integrated of the same order, we can run a Johansen cointegration test. There must be at least one cointegrating equation for the VECM to be applied. Table 3 shows the results from the unrestricted cointegration tests.

**Table 3: Unrestricted Cointegration Rank Test (Trace) Results**

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None * | 0.304462 | 63.06885 | 47.85613 | 0.0010 |
| At most 1 | 0.122020 | 25.30965 | 29.79707 | 0.1507 |
| At most 2 | 0.075808 | 11.77592 | 15.49471 | 0.1680 |
| At most 3 | 0.033810 | 3.577090 | 3.841466 | 0.0586 |

Trace test indicates 1 cointegrating equation(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

The results from the Johansen unrestricted cointegration tests indicates that the trace statistic is greater than the critical value, which implies that we do not reject the null hypothesis of none cointegrating equation. However, under the second null hypothesis of at least one cointegrating equation, the trace statistic is less than the critical value while the p-vale is greater than 0.05, implying that there is at least one cointegration equation. This means that it is now possible to proceed to the VECM.

**Table 4: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)**

| Hypothesized No. of CE(s) | Eigenvalue | Max-Eigen Statistic | 0.05 Critical Value | P-Value |
|---|---|---|---|---|
| None * | 0.304462 | 37.75920 | 27.58434 | 0.0018 |
| At most 1 | 0.122020 | 13.53373 | 21.13162 | 0.4044 |
| At most 2 | 0.075808 | 8.198832 | 14.26460 | 0.3588 |
| At most 3 | 0.033810 | 3.577090 | 3.841466 | 0.0586 |

Max-eigenvalue test indicates 1 cointegrating equation(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Similarly, the results from the unrestricted rank test indicates that the maximum eigen value is greater than the critical value under the null hypothesis of none cointegrating equation, implying that we reject the null hypothesis. Under the null hypothesis of at least one cointegrating equation, the maximum eigen value is less than the critical value while the p-value is greater than 0.05, implying that we cannot reject the null hypothesis of at least one cointegrating equation. However, the fact that the variables are cointegrated does not automatically mean that all the independent variables in the model have a significant influence on the dependent variable. To identify the variables which have an influence on the dependent variable, there is therefore need for a VECM estimation. The results of the VECM are indicated in table 5.

**Table 5: Vector Auto regression Estimates**

| | INFLN | MS | PEXRP | YGAP |
|---|---|---|---|---|
| **INFLN(-1)** | 1.427762<br>(0.07923)<br>[ 18.0215] | -0.004188<br>(0.00621)<br>[-0.67486] | 3.937587<br>(0.66257)<br>[ 5.94291] | 0.005599<br>(0.00530)<br>[ 1.05702] |

| | | | | |
|---|---|---|---|---|
| **INFLN(-2)** | -0.188228<br>(0.04317)<br>[-4.36038] | 0.001076<br>(0.00338)<br>[ 0.31815] | -1.119924<br>(0.36102)<br>[-3.10215] | 0.000319<br>(0.00289)<br>[ 0.11037] |
| **MS(-1)** | 1.166394<br>(1.34273)<br>[ 0.86867] | 1.167640<br>(0.10517)<br>[ 11.1023] | 28.00934<br>(11.2294)<br>[ 2.49430] | 0.072491<br>(0.08978)<br>[ 0.80746] |
| **MS(-2)** | -0.837537<br>(1.40768)<br>[-0.59498] | -0.135089<br>(0.11026)<br>[-1.22520] | -18.15764<br>(11.7726)<br>[-1.54237] | -0.081277<br>(0.09412)<br>[-0.86355] |
| **PEXRP(-1)** | 0.007621<br>(0.01286)<br>[ 0.59274] | 0.000374<br>(0.00101)<br>[ 0.37124] | 0.755907<br>(0.10753)<br>[ 7.02985] | -0.000562<br>(0.00086)<br>[-0.65329] |
| **PEXRP(-2)** | -0.012022<br>(0.01211)<br>[-0.99245] | -0.000663<br>(0.00095)<br>[-0.69831] | -0.096450<br>(0.10131)<br>[-0.95204] | 0.000445<br>(0.00081)<br>[ 0.54989] |
| **YGAP(-1)** | -0.760585<br>(0.64527)<br>[-1.17870] | 0.055784<br>(0.05054)<br>[ 1.10372] | -1.160683<br>(5.39647)<br>[-0.21508] | 1.863664<br>(0.04314)<br>[ 43.1967] |
| **YGAP(-2)** | 0.707760<br>(0.62963)<br>[ 1.12409] | -0.060386<br>(0.04932)<br>[-1.22446] | 0.631440<br>(5.26565)<br>[ 0.11992] | -0.870333<br>(0.04210)<br>[-20.6741] |
| **C** | -1.390751<br>(0.97253)<br>[-1.43004] | -0.067048<br>(0.07617)<br>[-0.88019] | -39.47277<br>(8.13331)<br>[-4.85322] | 0.052494<br>(0.06502)<br>[ 0.80729] |

Figures in ( ) are standard errors and those in [ ] are t-statistics

Table 5 indicates results of the VECM. The model of interest in this case is the first model where inflation is the dependent variable. However, to be able to determine the significance of the variables we first determine the respective p-values of the variables. In order to get the p-values of the variables, we have to estimate the relevant system equation. The system equation is as indicated below.

**System Equation**

D(INFLN) = C(1)*( INFLN(-1) + 4.33410293452*MS(-1) - 0.0794048742883*PEXRP(-1) - 0.315918331456*YGAP (-1) - 19.0592753123 ) + C(2)*D(INFLN(-1)) + C(3)*D(INFLN(-2)) + C(4)*D(MS(-1)) + C(5)*D(MS(-2)) + C(6)*D(PEXRP(-1)) + C(7)*D(PEXRP(-2)) + C(8)*D(YGAP(-1)) + C(9) *D(YGAP(-2)) + C(10)

The model has two parts. In the first part, the estimates of the long run effects are given while the second part contains the estimates of the short run dynamic interaction among the variables. The summarised results of this model are as indicated in Table 6.

**Table 6: VECM Results**

| | **Coefficient** | **Std. Error** | **t-Statistic** | **P-value** |
|---|---|---|---|---|
| C(1) | -0.143946 | 0.037555 | -3.832913 | 0.0002 |
| C(2) | 0.338357 | 0.119124 | 2.840384 | 0.0055 |
| C(3) | 0.104581 | 0.043681 | 2.394215 | 0.0186 |
| C(4) | 0.567627 | 1.290978 | 0.439687 | 0.6612 |

| | | | | |
|---|---|---|---|---|
| C(5) | -1.684261 | 1.275834 | -1.320126 | 0.1899 |
| C(6) | 0.016325 | 0.010770 | 1.515802 | 0.1329 |
| C(7) | -0.000892 | 0.011891 | -0.075003 | 0.9404 |
| C(8) | -0.594483 | 1.402193 | -0.423967 | 0.6725 |
| C(9) | 0.708908 | 1.379013 | 0.514069 | 0.6084 |
| C(10) | 0.247982 | 0.197660 | 1.254592 | 0.2127 |
| R-squared | 0.566188 | Mean dependent var | | 0.403917 |
| Adjusted R-squared | 0.525518 | S.D. dependent var | | 2.162692 |
| S.E. of regression | 1.489720 | Akaike info criterion | | 3.724642 |
| Sum squared resid | 213.0496 | Schwarz criterion | | 3.975910 |
| Log likelihood | -187.4060 | Hannan-Quinn criter. | | 3.826482 |
| F-statistic | 13.92153 | Durbin-Watson stat | | 1.947537 |
| Prob (F-statistic) | 0.000000 | | | |

The results indicate that the R-squared is 56.6 percent while the Durbin Watson test statistic is 1.9 which is very close to 2 and the F statistic is less than 0.05, implying that the model is robust. The results indicate that C(1) is negative and significant as shown by the p-value of less than 5 percent, implying that there is a long-run causality between money supply, inflation and output gap and inflation. In order to analyse the short-run dynamics, we perform the Wald Test.

From the system equation, if C(4) and C(5) are jointly equal to zero, it means that we do not reject the null hypothesis that there is no short-run causality between money supply and inflation. Similarly if C(6) and C(7) and C(8) and C(9) are jointly equal to zero, it also means that there is no short-run causality from the parallel exchange rate premium and the output day to inflation, respectively. The results of the Wald test are as indicated in Table 7.

**Table 7: Wald Test**

| | **Null Hypothesis** | **Chi-square** | **P-Value** |
|---|---|---|---|
| Money Supply | C(4)=C(5)=0 | 0.567627 | 0.0412 |
| Parallel Exchange Rate Premium | C(6)=C(7)=0 | 2.308416 | 0.0315 |
| Output Gap | C(8)=C(9)=0 | 0.348872 | 0. 3998 |

Table 7 indicates that the p-value is less than 0.05 for money supply and the parallel exchange rate premium, implying that we reject the null hypothesis and conclude that there is a short-run causality running from money supply and the parallel exchange rate premium to inflation. The p-value for the output gap is greater than 0.05, implying that we do not reject the null hypothesis that there is no causality running from the output gap to inflation.

## 6. Conclusion

This paper analysed the money supply, exchange rate and inflation dynamics in Zimbabwe for the period from December 2009 to December 2018. The paper first applied a multivariate regression model to identify the

significance of the independent variables on inflation in Zimbabwe. The result from the model indicates that money supply and the parallel market exchange rate premium had some significant influence on inflation. However, due to the limitations of the multivariate regression model, the study also used the VECM in order to eliminate the endogeniety problem and also to allow for the feedback mechanism in the model. This was done by first determining if the variables of interest were cointegrated.

The results from the Johansen unrestricted cointegration tests indicated that there was at least one cointegration equation, thus making it possible to proceed to the VECM to identify the variables which had an influence on the dependent variable. The paper established that money supply and the parallel exchange rate premium had an influence on inflation dynamics in Zimbabwe. The paper came up with interesting observations regarding inflation dynamics in Zimbabwe. In particular, the paper established that there is a long-run relationship between the money supply, the parallel market premium and the output gap and inflation. However, the paper also established that there is some short-run causality running from money supply and the parallel exchange rate premium to inflation. The output gap did not have some short-run causality on inflation.

These observations are very interesting for achieving long-run stability in Zimbabwe. This is because the trade-off between inflation and economic growth needs to be carefully managed for attainment of long lasting macroeconomic stability. The need to revamp economic activity often lead to money supply growth culminating in rising inflation and exchange rate depreciation. The resultant macroeconomic instability affects business confidence and investor confidence and harm economic growth. Therefore, authorities need to focus more on macroeconomic stability by curtailing money supply growth through commitment to a robust monetary targeting framework. Whilst it may constrain economic activity in the short-run, the attainment of macroeconomic stability will help boost business confidence and create a conducive environment for business.

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