

## THE DYNAMIC SPECIFICATION OF THE INFLATION MODEL IN ZIMBABWE

By

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### Abstract

*In order to estimate the inflation function in Zimbabwe we used cointegration and error-correction mechanism (a methodology popularized by Hendry et al (1989)). This approach has received extensive empirical support. Right now the approach seems to have generally settled the long-standing problem over the instability of the inflation model (function). Using the above technique, we managed to come up with a stable inflation model for Zimbabwe. This study also established that one must go beyond a simple monetary account of the inflation process even if inflation will always have a monetary dimension. Other factors that were found to be significant in explaining inflation in Zimbabwe are: real output, budget deficit, exchange rate depreciation and interest rates. The results that we got fitted very well all the theoretical priors, and they also concur with the studies done elsewhere for both the developed and the developing countries.*

### Introduction

In Zimbabwe inflation throughout the 1980s was relatively low, averaging around 13 percent. Relatively low inflation levels were against the background of a system of administered price controls and generally over-regulated business environment that led to generally depressed economic activity. The liberalisation and deregulation of the domestic economic environment, following the introduction of the Economic Structural Adjustment Programme (ESAP) in 1991, increased the role of market forces in the allocation of resources. Prices became more indicative of the fundamental developments in the economy with the removal of price controls. Against this background, and in an environment of limited competition due to a monopolistic production structure, an upward surge in inflation emerged.

After the introduction of the ESAP in 1991, Zimbabwe has seen episodes of high inflation. The policy makers excessively used tight monetary policy to combat inflation, but they failed to reduce it to the desired levels of less than 10%. This suggests that inflation may not always be and everywhere a monetary phenomenon as suggested by Friedman (1969). The preceding

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statement therefore suggests that monetary growth may not be the only cause of inflation in Zimbabwe. So a wider portfolio of policies which captures all the possible causes of inflation is needed if inflation is to be put at bay.

### **Why Study Inflation in Zimbabwe.**

Inflation has adverse consequences on economies some of which are uncertainty, distortion of the distribution of resources and the disabling of the economy's capacity to generate domestic savings as real incomes are eroded (ESAP Highlights, 1995). In this way inflation acts as tax on companies, households, and individuals, impacting negatively on low and fixed incomes such as those of minimum wages earners and pensioners. Inflation, particularly when unanticipated, transfers wealth from savers to borrowers as the value of monetary assets is eroded. Similarly, inflation redistributes income if wages and interest earned by holders of fixed financial assets rise at a slower rate than the rate of increase in inflation while the cost of buying goods and services rises with inflation. Unanticipated inflation also hinders effective operation of the credit markets, because the risk of borrowing and lending rises with every increase in the rate of inflation (Seigel, 1982).

Inflation, by increasing the risks and costs of holding and using money, erodes the usefulness of money and undermines the monetisation of a developing economy. It therefore, adversely affects the growth and output generating capacity of the economy.

Inflation erodes the value of financial savings and therefore acts as a deterrent to holding money especially over longer periods. Investors end up diverting financial assets into very short-term investments or into fixed assets such as land and buildings as hedges against inflation. Increasing prices thus undermine the important intermediary role of financial institutions of mobilising deposits from savers and making them available as loans and advances to productive investors.

By reducing the flow of savings that can be channeled to those investments that are too large to be financed from own resources, inflation denies the economy access to financial resources vital for productive investments which an economy's growth potential depends on. Inflation, unless arrested, can have extensive adverse consequences on the economies that include low investment, reduced general availability of goods and services, and low employment generation. This may result in stagflation-a situation of rising inflation and falling economic growth (Seigel, 1982).

Other consequences of high inflation are high nominal interest rates arising from the need to encourage savings by maintaining positive real rates of interest. Failure to raise nominal rates in response to the rise of inflation would lead to negative real interest rates that encourage dissaving and increased consumption. It is against this background that nominal interest rates have remained high in Zimbabwe. High nominal interest rates, however, have adverse consequences on the cost of borrowing to industry and on investment and general economic growth.

Inflation also has adverse consequences on the stability of the exchange rate and, in turn, exports competitiveness and foreign investment inflows. Environments of high inflation levels

often require continuous exchange rate devaluation as the authorities strive to maintain export competitiveness and stem capital flight. Imports, however, become more expensive as depreciation of the local currency takes place and this increases inputs costs to industry, consequently making domestically produced goods more expensive on export markets. To maintain competitiveness, further devaluation often becomes necessary, which generates a new round of inflation through higher production costs.

This, however, leads to ever rising rates of inflation as one round of inflation leads into the next, trapping the economy in a vicious inflation spiral. The worst evils of inflation then emerge as the ever-rising and accelerated growth in inflation translates into hyperinflation as experienced in most Latin American economies in the 1970-80s with inflation rates rising as high as 70 percent per annum. By the year 2000, Zimbabwe's inflation rate stood at 55.9 percent.

The impact of the 1992 drought and its adverse consequences on agricultural output and agro-based industries also affected the supply of domestic goods, government's revenue base, and consequently government expenditures. This saw the government increasing its borrowing from the domestic bank sources in order to import foodstuffs; and this resulted in adverse consequences on money supply growth and inflation (RBZ Publications, 1995).

It is against this background that it becomes important to establish the arguments of inflation, so that appropriate measures to cure it can be taken. The knowledge that emanates from a study of the determinants of inflation is indispensable in designing effective stabilisation policies.

### **Organization of the paper**

The rest of the paper is organized as follows:

Chapter 2 reviews the literature relevant for this study; Chapter 3 looks at the methodology used by the researcher in analyzing inflation in Zimbabwe. Chapter 4 analyses the results obtained from the estimation, and Chapter 5 concludes the study with policy recommendations.

### **Literature Review**

There are various theories that explain the inflation phenomenon, viz: demand-pull approaches (the monetarist, and the Keynesian), the cost-push approach, the structuralist approach and the rational expectations approach. It is not my intention to go into the details of these theoretical approaches because that will make the paper unnecessarily long. The research will therefore only review relevant empirical literature. A lot of official empirical literature on the inflation phenomenon exists in both the developed and developing nations, though little specifically on Zimbabwe. Below are some of the representative studies in the area.

Khan (1980) attempted to verify the efficacy of monetary policy to the problem of inflation, by looking at seven Latin American Countries and four Asian countries. He assumed that monetary growth causes inflation. He also went on to assert that money holders expect the authorities to keep monetary growth in line with the growth in nominal money demand; and that the inflationary process is monetary in character and hence monetary policy was considered as the only instrument for controlling inflation.

Khan went on to say that non-monetary factors such as wage changes, import price and exchange rate fluctuations can be independently important in affecting prices and inflation can often be controlled by suitable fiscal, exchange rate and incomes policies. Since Khan's study left out the latter variables this makes his study incomplete. Using a single equation regression model, Khan found out that inflation is a monetary phenomenon in all the countries that he studied. A major weakness of Khan's study is that it focused exclusively on the relationship between inflation and the growth of the money supply, an approach that would be strictly valid only for a closed economy or one with a freely floating exchange rate.<sup>1</sup>

Moser (1995) developed an error-correction model of the inflationary process for Nigeria. Moser estimated the long run (co integrating relationship) and the short run (error correction model) models of inflation. The results of Moser's analysis confirm the basic findings of earlier studies<sup>2</sup>, namely, that monetary expansion, driven mainly by expansionary fiscal policies, explains to a large degree the inflationary process in Nigeria. Other important factors according to Moser are the devaluation of the Naira and agro-climatic conditions. The main advantage of the method of estimation used by Moser is that it tests for the stationarity of the variables and therefore eradicates the problem of the existence of spurious relationships among variables.<sup>3</sup>

Chhibber *et al* (1989) studied the inflation dynamics in Zimbabwe for the period 1969 to 1986. They used the method of Two Stage Least Squares to make their estimations. Their study identified unit labour costs and interest rates in addition to exchange rates, foreign prices, monetary growth, and real income growth as factors explaining inflation in Zimbabwe. This study was carried out for an economic environment different from the one Zimbabwe is experiencing at the moment. During the period before 1980 the Zimbabwean economy was characterised by economic sanctions and after independence in 1980 it was characterised by price controls, foreign exchange controls, rising subsidies and many other government interventions which introduced imperfections in the market. These controls caused the relationship between prices, monetary growth, and exchange rates movements to weaken. In such an economy, monetary policy alone was not effective, unless if it was adulterated with fiscal policy.

The current study is going to make use of quarterly data instead of annual data that was used in the study on Zimbabwe that has been reviewed. This makes us have a satisfactory number of observations since this study only focuses on the 1991-2000 period.

### **Model of Inflation for Zimbabwe**

The preceding review of the empirical literature gives some insight into how best the dynamics of inflation in Zimbabwe can be modelled. Thus, from the review in the previous chapter the long-run model of inflation for Zimbabwe can be specified in the traditional way as follows:

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<sup>1</sup> A freely floating exchange rate does not affect real economic variables.

<sup>2</sup> See, for example Darrat (1985), Ekpo (1992), and World Bank (1993).

<sup>3</sup> Regressions involving time series data include the possibility of obtaining dubious results in the sense that results look good but on further probing they look suspect. Conventional regression techniques assumed econometric data to be stationary while, in reality, most of it is non-stationary. So the error correction and cointegration techniques take account of the non-stationarity of data.

$$CPI = F(M, Y, R, E, BD, RW) \quad (1)$$

$\begin{matrix} + & - & + & + & + & + \\ + & & & & & \end{matrix}$

Where:

CPI is the consumer price index,  
M is money supply  
Y is real output,  
R is the nominal rate of interest,  
E is the exchange rate,  
BD is the budget deficit, and  
RW is the real wage.

The sign below each explanatory variable shows the theoretical or expected relationship that exists between the dependent variable and the respective explanatory variable.

### Modeling strategy

The modeling strategy adopted in this study is the general to specific method made popular by Hendry (1986) and his colleagues at the London School of Economics and the University of Oxford. The first step is to specify an unrestricted autoregressive distributed lag (ADL) model which makes the dependent variable (Zimbabwe CPI) a function of its lagged values and the current and lagged values of the independent variables contained in equation (1). The long-run model is presented in the following autoregressive distributed lag (ADL) form: (2)

Where  $\lambda$  is the lag operator,  $A, B, C, D, E, F, G,$  and  $H$  are vectors of coefficients to be estimated and  $\epsilon_t$  is an error term. As will be seen later, these variables were generated so that they can be used in the stationarity and cointegration tests.<sup>1</sup>

The second step is to identify the time series characteristics of the variables in the ADL model. That involves testing for the stationarity of variables using the Augmented Dickey Fuller (ADF) test (Engle and Granger 1987).

Once the order of integration is established for each variable in the model, it is possible to move on to the next step of the approach, which is to find out if there is a cointegrating relationship between the dependent variable and any of the independent variables in the model. In intuitive terms, the first step here involves estimating the regression with variables in their levels. This is the long-run relationship of the variables. However, in order to test for cointegration between the dependent variable and any independent variable, the two variables must be integrated of the same order. For economic variables to have meaningful long-run relationships, it is necessary that such variables move together in the long run; that is, the variables must be cointegrated. A sufficient condition for this is that there should be linear

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<sup>1</sup> Following common practice (Hendry, 1989; Adam, 1992), the variables in the model were converted into logarithms before econometric techniques were applied to test for stationarity; order of integration and cointegration, and the ECM was specified and estimated. In the rest of the paper, therefore, the logs of variables appearing in upper case above appear in lower case.

combinations of these variables that are stationary<sup>2</sup>. Step one of the two-step technique tests for the stationarity of the residuals generated from the estimated long-run regression. If these residuals are stationary, the variables are cointegrated. Once the existence of a cointegrating relationship has been confirmed, the next step would be to generate an error correction model (ECM).

The interpretation and use of the results from the two-step technique are often confusing. What needs to be noted is that the ECM starts from the recognition that the variables in the model under investigation are non-stationary; in particular that they are integrated of the same order.<sup>3</sup> The stationarity of the residuals from step one of the technique means that the variables move together in the long run such that there exists a meaningful economic relationship among them. This relationship is summarised in the ECM with the error correction term capturing the long-run relationship between the variables in the model. It should be noted that the standard errors and therefore the t-statistics of the coefficients in the regression in step one of the technique are meaningless: we do not know the distribution of the parameters in that regression since the variables therein are non-stationary. As such, no logical inference can be drawn using these coefficients since we can not tell apriori about whether such coefficients are significant or not.

### Empirical Analysis

The major objective of this study is to establish whether financial reforms have led to changes in the factors that affect inflation in Zimbabwe. In this section the estimates based on the cointegration technique are discussed. The empirical analysis is based on the results obtained from the use of PCGIVE 8.0 an iterative econometric modelling system. In estimating the inflation function, dynamic structures are important and shed light on how equilibrium is attained. This is addressed through the two-stage error correction model as suggested by Hendry (1986), Granger (1986) and Engle and Granger (1987). The first stage concerns testing for the order of integration of all the lagged variables, that is, **cpi**, **m2**, **y**, **rus**, **r**, and **rw**, in the model. The budget deficit (**BD**) will be used in levels because there are also some negative figures in this series; and logs of negative figures do not make sense. Using the ADF test it was established that the variables were not stationary in levels while the first differences were. The hypothesis for a unit root in **cpi**, **m2**, **y**, **r**, **BD**, **rus**, and **rw** was strongly rejected meaning that all variables are integrated of the same order one [I (1)]. This means that the level terms had to be differenced once to induce stationarity.

From some experiments using the Zimbabwean dollar over South African Rand exchange rate, we found out that this rate was insignificant in explaining the inflation phenomenon in Zimbabwe. We also established that the M2 definition of money statistically performed better than the M1 and M3 definitions.

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<sup>2</sup> See Deadman et.al (1993)

<sup>3</sup> A variable is said to be integrated of order one if it requires to be differenced once to become stationary (Granger et.al, 1987).

The coefficients of the long run model are presented in table 1 and the results of the error correction model are presented in table 2. Only the coefficients of the long run model are presented because the long run model results do not make sense due to the presence of spurious relationships among variables.

**Table 1. The Long-run model coefficients Dependent variable is cpi**

Variable	Coefficient
Constant	15.644
<b>m2(-1)</b>	0.009
<b>y (-1)</b>	-0.072
<b>Eus (-1)</b>	0.865
<b>r(-1)</b>	1.079
<b>BD (-1)</b>	0.003
<b>rw (-1)</b>	0.003

The residuals from the above regression are stationary. This means that a cointegrating relationship exists among the variables that were included in this model. It is the existence of such a relationship that allows us to come up with an ECM. Again using the general-to-specific modeling strategy described above, the lag structure in the above results was found most appropriate after considering different formulations. The results of the short-run error correction model are summarized in table 2 below.

**Table 2: The short-run E.C.M. Model Results Dependent variable is  $\Delta$ CPI**

Variable	Coefficient	Std Error	t-statistic	Probability
Constant	20.101	24.693	0.814	0.4240
$\Delta$ <b>m2(-1)</b>	0.088	0.001	10.863	0.0001
$\Delta$ <b>y (-1)</b>	-0.051	0.003	-3.380	0.0073
$\Delta$ <b>eus(-1)</b>	0.364	0.912	2.728	0.0041
$\Delta$ <b>BD(-1)</b>	0.011	0.632	2.744	0.0531
$\Delta$ <b>r (-1)</b>	0.4015	0.233	3.718	0.0001
$\Delta$ <b>rw (-1)</b>	0.0058	0.011	0.536	0.5974
$\Delta$ <b>cpi<sub>t-1</sub>(-1)</b>	0.6354	0.010	2.998	0.0023
<b>res (-1)</b>	-0.8466	0.059	-4.642	0.0001

$R^2$  (adjusted) = 0.7365

F (6,23) = 1118.9 [0.0000]

DW = 2.08

RSS = 0.623897



The above results show that all the independent variables (with a lag of one quarter except the real wage and the constant are significant explanatory variables of the movement in the aggregate consumer price index (CPI)). The error correction term (**res (-1)**) is also significant at the 5 percent level. Thus, the general price level adjusts at the rate of 85 percent of the gap between its long-run level and the current level in each period. In other words the short-run changes in the price level have significant positive effects on CPI and that about 85 percent of the discrepancy between the actual and the long run, or equilibrium, value of CPI is eliminated or corrected each quarter.

An important thing to note from the results in Table 2 is the relative importance of the various coefficients in the model. About 64 percent of the previous period's inflation is transmitted into the current period's inflation. This can be interpreted as reflecting strong "backward-looking" expectations in the Zimbabwean economy. Thus, economic agents anticipate the future level of inflation to be close to what it was the last period. The Zimbabwean dollar over US dollar exchange rate also accounts for about 36 percent of every 1 percent change in aggregate **cpi**. The study also found out that about 40 percent of every one percent change in aggregate **cpi** is accounted for by the interest rate. Although **y** and **m2** are significant explanatory variables their elasticities as given by their coefficients are relatively very low (around 5 percent and 9 percent respectively). Another important thing to note is that although the **rw** variable has the correct sign it is insignificant. The **BD** is also significant at 10 percent level and this authenticates that budget deficits are inflationary.

Given the relative inadequacy of the data and the relatively small sample the results are quite satisfactory since from the results it is clear that the error correction equation fits the data very well as suggested by  $R^2$  adjusted for the degrees of freedom and the small residual sum of squares (RSS). The F test which is significant at both 1 percent and 5 percent levels shows that the model is of a good fit. These diagnostic tests also rejected the presence of serial autocorrelation in the data even if variables are lagged three times. Individually the lags of one were found significant at 5 percent level of significance. However, collectively the lags were found insignificant. We also tested for the stability of the model using the Chow test. This test gives information about the important attributes of a good model. The study, therefore, established that there was no parameter shift meaning also that there was no behavioral break in the period under study.

The error correction term, which has the correct negative sign, shows that in Zimbabwe there is elimination of the discrepancy between the long run and short-run inflation rates whenever equilibrium is disturbed in the short-run. This suggests that inflation do adjust towards its long run value. All in all given the limitations of secondary data and the use of interpolated output and real wage figures the error correction model performed well in an econometric sense.

### **Conclusion and Policy Implications**

This analysis of the determinants of the inflationary process has potentially important implications for economic management in Zimbabwe. This is a major issue in 2000 when Zimbabwe wants to reduce the inflation levels, which have adamantly remained high throughout the ESAP 1 and the Zimbabwe Programme of Economic and Social Transformation (ZIMPREST)<sup>7</sup> eras. The reduction



of inflation, especially, during the Millennium Economic Recovery Program (MERP)<sup>8</sup> era would ensure a stable macroeconomic environment; and such an environment is conducive to foreign investors. From the results it is clearly necessary to go beyond a simple monetary account of the inflationary process in Zimbabwe, even if inflation will always have a monetary dimension.

From the results the following variables are important in explaining the inflation phenomenon in Zimbabwe: money supply growth, real output growth, exchange rate depreciation, budget deficit and nominal deposit rates. The following table, which is derived from the results, summarises the relationship between the dependent variable and the independent variables and also categorises the explanatory variables that were used in the estimation process.

**Table 3 Variable, sign of coefficient, and category.**

<b>Variable</b>	<b>Sign of coefficient</b>	<b>Category</b>
Money supply	Positive	Monetary
Output growth	Negative	Structural
Exchange rate depreciation	Positive	Structural/Cost-push
Deposit rates	Positive	Monetary
Budget deficits	Positive	Structural
Real wages	Positive	Cost-push

Since only the real wages were insignificant in the ECM this means that monetary, cost-push and structural variables are all important in explaining the inflationary process in Zimbabwe. We can therefore safely say that financial reforms have changed the inflation phenomenon in Zimbabwe since we now have additional variables like budget deficit and interest rates being significant explanatory variables of the inflationary process. So we need a policy mix in Zimbabwe rather than only invoking monetary policy, which has failed to give the desired results.

Money supply growth whose elasticity is less than one just like all the other significant variables in this study should be closely monitored if inflation is to be reduced to the desired levels. Government budget deficit has been found significant in this study. This implies that if we want to reduce inflation by using tight monetary policy we also have to put in place fiscal policy aimed at reducing the magnitude of our fiscal deficit.

<sup>7</sup> The Zimbabwe Programme of Economic and Social Transformation was supposed to be implemented between 1995 and 2000. However, it failed to take off due to lack of support from the Bretton Woods institutions and other multilateral donors and financiers.

<sup>8</sup> MERP was introduced in the year 2000.

It is also important to note that for a given level of overall output production in the economy there is a desired level of money stock which is consistent with low and stable inflation conditions, the additional money created becomes inconsistent with economic activity and, therefore, becomes inflationary. It is therefore important for the policy makers to determine this level of money supply that is consistent with the current level of output production if our economy is to suppress the emergence of inflationary pressures.

The Z\$/US\$ exchange rate which was found to be significant, also, has important policy implications. The speed of adjustment of the exchange rate in the short-run towards its long-run equilibrium allows for some flexibility in the exchange rate policy. Devaluation of the exchange could be used as a tool to enhance competitiveness, and domestic monetary measures could be used to contain the short-run inflationary pressures that could result. In addition, the Lucas critique would argue that a policy of continuous devaluation would lead agents to adjust their behaviour to take account of the repeated devaluation, limiting the effectiveness of the policy.

The opposite policy of exchange rate appreciation to achieve inflation lower than in the USA could only be achieved at the cost of reduced short-run competitiveness for domestic producers. This would make the task of export diversification even more difficult.

Output should also be monitored closely if we are to successfully reduce the inflationary pressures. An increase in output (aggregate supply) without a corresponding increase in aggregate demand lowers the price and vice versa. For the economy to increase output it should create a conducive investment environment and a sound investment policy. With the introduction of ESAP the pricing system was decontrolled and firms can now charge prices that are consistent with the level of output. However, as a result of the monopolistic productive sector and the prevalence of drought episodes, output has remained very low and prices high.

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