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The Impact of Exchange Rates on Inflation Dynamics in Zimbabwe

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Abstract- The study used the Autoregressive Distributed Lag model to assess the impact of exchange rates on inflation dynamics in Zimbabwe with other selected macroeconomic variables such as dollarisation, trade openness and gross domestic product for the period of 1980 to 2017. Data were taken from the ZIMSTATS and World Bank databases. The study employed error correction model (ECM) to examine the short run dynamic relationship between Inflation and other macroeconomic variables. The time series properties of the data were first analysed using the Augmented Dickey-Fuller (ADF) test. The empirical results derived indicated that all variables were stationery after first differencing, that is all variables are integrated of order one I(1). The study further established that there is no cointegration between variables and inflation indicating no long-run relationship. Only a short-run relationship between variables was established. The short-run relation indicates that exchange rate has positive impact on inflation rates. The short run model also indicated that second lagged period of exchange rate, one lagged period of trade openness and dollarisation have negative effects on inflation in the short-run. The study further investigated the causal relationship using the Granger Causality test, which indicated a bidirectional relationship between inflation and exchange rates and similarly with dollarisation and gross domestic product. The Granger Causality test also revealed a unidirectional relationship between trade openness and dollarisation. In context of dollarisation and inflation, inflation and gross domestic product, trade openness and inflation, exchange rates and dollarisation and trade openness and exchange rates, there was an independent granger causality relationship in the short run at 5%. This means that exchange rate has a short-run relationship with inflation and influences it positively in Zimbabwe. These findings therefore recommended that policies that encourage investment in the manufacturing sector be formulated and implemented in order to reduce the competitiveness of imports. It is also recommended that the South African Rand be adopted as the main currency in order to reduce the economy's exposure to exchange rate risk.

Keywords – Inflation, Exchange Rates, Autoregressive Distribution Lag.

I. INTRODUCTION

Exchange rate is the price of one currency in relation to another. The exchange rate-inflation relationship is of vital importance, especially in emerging economies since exchange rate fluctuations can significantly affect the general level of prices. Zimbabwe experienced high inflation levels since 2000, which later morphed into hyperinflation in March 2007. Yearly inflation topped at 231 million percent in July 2008. Amid the high inflation time frame, the nation posted tremendous negative development rates, which bottomed to - 14.7% in 2008. Resultantly, there is a general accord that high inflation has distortional consequences for financial development in Zimbabwe [1]. The introduction of multi-currency regime in January 2009 prompted some solidness in the economy and inflation level declined to as low as low as –7.7% in December 2009. Yearly inflation rose from 3.03% in 2010 to 3.48% in 2011 and 3.72% in 2012 and after that it declined from 2013 to 2017 to single digits [2]. In spite of the stability brought about by the multicurrency exchange rate regime, debate continues to which currency to adopt as the official currency in Zimbabwe. [3], suggests that high inflation has negative effect on the economy through loss of competitiveness and thereby adversely impacting on a country's balance of payments. High inflation also influences venture choices as it achieves vulnerability on the future estimation of speculation ventures and furthermore

disintegrates the genuine estimation of expense incomes. Zimbabwe experienced an outright reversal of high inflation when it realized deflation for 28 consecutive months from October 2014 to January 2017. Annual inflation reached its lowest level of -2.41% in 2015 [1]. The introduction of bond notes in 2016 pegged to the USD prompted the development of a parallel market for remote trade attributable to deficiency of foreign currency. The introduction of bond notes in November 2016 somewhat eased liquidity shortages by increasing cash supply. However, the aspects of the underlying macroeconomic imbalances were not addressed. According to [4], inflation is mainly driven by money creation to fiscal deficit. It stood at 0.06% in February 2017 and closed the year at 3.46% before rising to 3.52% in January 2018. The economy suffered from liquidity issues and the existence of a basket of currencies. Deposits in Zimbabwean banks functioned as a separate currency and a parallel exchange rate for cash withdrawals and payments abroad emerged. A Street based parallel market also emerged to exchange deposits into USD. The adoption of USD as the leading currency had some influence on the exchange rates dynamics. With the policy makers having lost power over monetary policy, the exchange rates between currencies within the Zimbabwean boundaries were seen moving freely. The exchange rates fluctuated within the ranges from ZAR6.9003/USD to ZAR10.9601/USD. Such movements in exchange rates had an effect on the rates of inflation which prevailed within the economy. According to [4], inflation rates were moving between -7.7% and -1.6%. This indicated that there are times when the economy would be in a deflation while at times the general price level was seen as increasing.

Research Problem

Although a number of researchers have carried out research on how inflation has affected exchange rates, diverse examinations have been created to examine the connection between inflation pattern and exchange rates. In a dollarized Zimbabwe, such proposals did not turn out to be appropriate. Rather, instead of inflation influencing exchange rates, which is seen to be the usual norm, the opposite seem to be true in the Zimbabwean economy. It is thus worth examining the short and long run relationships between exchange rates and consumer price index in Zimbabwe.

Empirical Findings

[5], examined the impact of exchange rate depreciation on inflation in Nigeria for the period 1986-2008, using Auto Regressive Distributed Lag (ARDL) cointegration procedure. The variables employed in the investigation include inflation rate, nominal exchange rate, money supply, government expenditure and real gross domestic product (RGDP). The empirical findings showed that exchange rate depreciation, money supply and real gross domestic product are the main determinants of inflation and that exchange rate depreciation has positive and significant long run effect on inflation in Nigeria. The paper therefore recommended the need for policy-makers to employ exchange rate depreciation as a measure to compliment other macro-economic policies to stabilize the volatile inflationary rate in Nigeria. [6] examined the effect of dollarization on inflation in Turkey. The study employed the autoregressive distributed lag (ARDL) modeling and the bounds testing approach to cointegration analysis to estimate an inflation equation for Turkey taking into consideration both monetary and fiscal variables as well as a dollarization variable. Results from ARDL approach indicated that broad money supply, dollarization and exchange rates impacted inflation positively in the long run. Only dollarization and exchange rate had significant and positive relationship with inflation in the short run.

The rest of the paper is organized as follows: Methodology in section II, Analysis and Results Discussion in section III and Concluding remarks are given in section IV.

II. METHODOLOGY

A. Research Design and Methodology

In this examination, an exploratory research design was utilized. Fundamental motivation behind exploratory research design are to satisfy the specialist's interest and requirement for more prominent comprehension, to test the reasonableness of starting an increasingly through and through audit, and moreover to develop the methods to be used as a piece of any after research adventures. This research design is appropriate for this study because it ensures an in-depth analysis and description of the various phenomena under investigation. The emphasis was on investigating the impact of exchange rates on inflation dynamics in Zimbabwe. This study employed quantitative research methodology. Quantitative methodology depends on numerical or quantitative data and is normally connected with measurable examination. It is applied when the objectives are based on a cause and effect relationship; that is, the research analyses the effects of one variable on another. This design is more suitable when

the research is focused on trying to understand, explain, predict and control associations among variables which go beyond qualitative analysis [7]. Quantitative research also involves data collection that is typically numeric and the researcher tends to use mathematical models as the methodology of data analysis. Additionally, the researcher uses the inquiry methods to ensure alignment with statistical data collection methodology [8]. [9] asserts that quantitative research originated in the physical sciences, particularly in chemistry and physics. The researcher uses mathematical models as the methodology of data analysis. Three historical trends pertaining to quantitative research include research design, test and measurement procedures, and statistical analysis.

B. Data

The study employed annual time series data covering a period of 38 years from 1980 to 2017. E-views 10 and SPSS 2.0 were used to analyze the short and long run relationships between exchange rate and inflation. For graphical analysis, Microsoft excel and SPSS were used . The research employed data from publications by the World Bank and the Zimbabwe Statistical Agency (ZIMSTATS) for the period of 1980 to 2017. This gave a sample size of thirty eight observations, a size which can be considered reasonable enough to give reliable results. The sample can be justified as it is in line with the variables among which the researcher wished to establish the relationship during the period under consideration. Secondary data was used for establishing the extent to which exchange rates impact inflation.

C. Descripton of Variables and Justification of Inclusion in Study

Table 1 below gives an outline of variables used in the study and their respective proxies.

Table 1: Variables to be used in the study

Variables	**Symbol**	**Indicator**	**Source**
Economic growth	EC	Natural logarithms of Gross Domestics Product (EC) (US $)	World Bank
Inflation	INFL	Natural logarithms of the CPI.	Zimbabwe National Statistics Agencies (ZIMSTATS)
Dollarisation	DOLL	A dummy variable taking the value of 0 values from the period of 1990-2008 and 1 prior period of dollarization Boole (1854)	
Trade Openness	TOP	Natural logarithm of total trade (imports plus exports) (local currency)	World Bank
Exchange Rates	ER	Natural logarithm of annual exchange rates	ZIMSTATS and World Bank

- *Inflation*

Inflation is best depicted as an increment in cost of living in general, where cost swelling diminishes buying power of a currency. Volatility in inflation rates and high rates of inflation deter economic growth hence all monetary policies should aim to achieve low inflation and ensure stability [10]. Inflation is the main variable under study hence it is important to establish its relationship with exchange rate and other key financial performance indicators (FPIs). Theoretically, a low inflation rate scenario will exhibit a rising currency rate, as the purchasing power of the currency will increase as compared to other currencies. Inflation has a couple of pointers, for example, consumer price Index (CPI), wholesale price index (WPI), Old Mutual implied rate and implicit price index (deflator EC), but in this study consumer price index (CPI) was used as a measure of inflation [11].

- *Exchange Rate*

Exchange rate is a value that a currency has compared to another currency [11]. [11], expressed that exchange rate can be separated into two classes, that is, fixed exchange rates and adaptable exchange rates. In a fixed exchange rate, the exchange rate is set by the government whereas a flexible exchange rate is set by the market with or without the influence of the government in an effort to stabilize the monetary value [11]. It makes sense to include exchange rate in this study because it the critical predictor variable being assessed the suitability of its antecedency in predicting inflation dynamics in Zimbabawe.

- *Economic Growth*

According to the [12], GDP provides sufficient detail on the performance of an economy relative to its size such that GDP growth is a sign of economic growth. This justifies the use of GDP growth to measure economic growth in this study.

- *Trade Openness*

Trade openness gives us a clearer image of the general universal intensity of neighborhood items versus remote items. This is relied upon to positively affect monetary development for the period under examination. Trade openness variable is borrowed from the theory of Optimum Currency Areas as it was highlighted by [13] and [14] as a key component because it reflects the level of economic integration between Zimbabwe and its' trading or anchor countries.

- *Dollarisation*

Dollarisation was defined by [15] as the adoption of foreign currency as legal tender while [16] concluded that a country should forego its national bank when it dollarises. Informal dollarisation implies that natives incline toward use of foreign currency for certain exchanges, despite the fact that it may not be legal tender. Official dollarisation implies formal adoption of foreign currency usage by the government. According to [17], the economy is using approximately more than 70% of USD in transactions, pricing and tax purposes. This is because dollarisation was made official in February 2009 although the Reserve Bank of Zimbabwe had started issuing out official licenses to retail operators to trade in foreign currency during the last quarter of 2008. Not sufficient data is available in Zimbabwe to measure dollarisation therefore a dummy variable is going to be used as a proxy. 1 represent period under dollarization and 0 represent period of local currency use.

Table 2:Expected Variable Signs/Effect on Inflation

Variable	**Expected Sign**	**Explanation**
Exchange rates	+	**A rise in exchange rates will tend to increase prices of products resulting in increased inflation rate. (Dornbuch, 1976)**

Dollarisation	**-**	**Dollarisation is expected to lower the inflation rate because the more the country becomes dollarized the more the financial sector becomes stable. Alesina and Barro (2001 p. 382)**
Trade Openness	+	**An increase in trade openness would have an impact on economic growth positively.**
Economic growth	+	**It is expected that as EC increases inflation will tend to increase as well. (Fischer, 1993).**

D. Autoregressive Distributed Lag (ARDL)

- Theoretical model

II. 3.6.1 THE THEORETICAL MODEL

The hypothetical model utilized in this examination is given by:

$$INFLTN_t = f(ER_t, DOLL_t, EC_t, TOP_t, INFLTN_{t-1}) \quad (1)$$

The multiplicative form of the above equation is:

$$INFLN_t = \alpha_0 ER_t^{\alpha_1} DOLL_t^{\alpha_2} EC_t^{\alpha_3} TOP_t^{\alpha_4} INFLN_{t-1}^{\alpha_5} \varepsilon^{\mu_t} \quad (2)$$

By taking natural log of each variable, the multiplicative equation can be expressed as follows:

$$lnINFLN_t = ln\alpha_0 + \alpha_1 lnER_t + \alpha_2 lnDOLL_t + \alpha_3 lnEC_t + \alpha_4 lnTOP_t + \alpha_5 lnINFLN_{t-1} + \mu_t \quad (3)$$

- Multicollinearity Tests

Multicollinearity occurs when two or more predictors in the model are correlated and this provides false information about the response. It is a problem in polynomial regression caused by improper use of dummy variables, including a variable that is computed from other variables in the equation, including the same or almost the same variable

twice [18] Pair wise correlation test was conducted in this study to test for multicollinearity among variables. According to [18], a value of 0.8 or more indicates the presence of a higher multicollinearity between variables which violates the classical linear regression assumptions.

- *Unit Root Test*

It is important to know the characteristics of the data, in particular, whether the time series data is stationary or not. Using non-stationary data in a regression can lead to spurious results [19]. To test for stationarity, the Augmented Dickey Fulller (ADF) unit root test is used [20]. The null hypothesis that a variable contains a unit root is tested against the alternative of no unit root/ the variable is stationary. The ADF is used to determine order of integration to ensure that variables are not integrated of order 2 that is I(2) which is the requirement for the ARDL model. Two models for ADF tests were used; one with intercept only and one with intercept and trend [19]. Variables which are I(0) are integrated of order zero, meaning that they are stationary in levels or have no unit roots. I(1) variables, in contrast, are integrated at the first order, meaning that they contain a unit root and they can be stationary after first order differencing [21]. If variables are I(1), further tests for I(2) may be required. If the variables are I(2), the calculated F-Statistic of the bounds tests is taken as invalid because it is based on the assumptions that variables are I(1) or I(0) , [19]. Variables that are I(2) may lead to crashing of the ARDL model [19]. Lag determination for ADF is based on the significant spikes of the autocorrelation function (ACF) plots and partial autocorrelation function (PACF) plots [19]. The number of the spikes at which ACF truncates or number of spikes of the PACF which are significantly different from zero are taken as optimal lag lengths for ADF [19].

- *Model Specification*

[22] proposed Autoregressive Distributed Lag (ARDL) way to deal with co integration or headed system for a long run relationship, independent of whether the hidden factors are I(0), I(1) or a combination of both. This paper utilised the ARDL model to investigate the impact of exchange rate on inflation dynamics in Zimbabwe. The use of ARDL way to deal with cointegration will give sensible and effective results. In contrast to the Johansen and Juselius (1990) cointegration method, Autoregressive Distributed Lag (ARDL) way to deal with cointegration helps in distinguishing the cointegrating vectors. That is, every one of the hidden factors remains as a solitary long run relationship condition. On the off chance that one cointegrating vector that is the hidden condition is recognized, the ARDL model of the cointegrating vector is reparameterised into ECM. The reparameterised result gives short-run elements (for example customary ARDL) and long run relationship of the factors of a solitary model. The re-parameterization is conceivable on the grounds that the ARDL is a dynamic single model condition and of a similar structure with the ECM. Distributed lag Model simply means the inclusion of unrestricted lag of the regressors in a regression function. The ARDL Model has a few points of interest, since each of the underlying variables stands as a single equation. Endogeneity is less of a problem in the ARDL technique because it is free of residual correlation, that is, all variables are assumed endogenous. Also, it enables us analyze the reference model. At the point when there is a single long run relationship, the ARDL technique can recognize reliant and informative factors, that is, the ARDL approach accepts that just a solitary diminished structure condition relationship exists between the needy variable and the exogenous factors [22]. The major advantage of this approach lies in its identification of the cointegrating vectors where there are multiple cointegrating vectors. The Error Correction Model (ECM) can be derived from ARDL model through a simple linear transformation, which integrates short run adjustments with long run equilibrium without losing long run information. The associated ECM model takes a sufficient number of lags to capture the data generating process in general to specific modeling frameworks.

- *Cointegration Test – the ARDL Bounds Test*

The ARDL bounds testing procedure is used to investigate the existence of a long run association between inflation and the financial performance indicators described previously [23]. After the stationarity test, the ARDL bounds test is applied to yield consistent and asymptotically long run coefficients [24]. The test can be applied irrespective of whether the predictors are I(0) or I(1). The cointegration approach involves estimating the conditional error correction model (CECM) of each of the equations [25], as shown in equation (4) below. The bounds test then entails a Wald/ F-test on each of the equations with the restriction that the estimated long run coefficients are equal to zero.

$$\Delta ln\ INFLN_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta lnER_{t-i} + \sum_{i=1}^{n} \alpha_2 \Delta lnDOLL_{t-i} + \sum_{i=1}^{n} \alpha_3 \Delta lnEC_{t-i} + \sum_{i=1}^{n} \alpha_4 \Delta lnTOP_{t-i} + \sum_{i=1}^{n} \alpha_5 \Delta lnINFLN_{t-i} + \beta_1 lnER_{t-1} + \beta_2 lnDOLL_{t-1} + \beta_3 lnEC_{t-1} + \beta_4 lnTOP_{t-1} + \beta_5 lnINFLN_{t-1} + \mu_t \quad (4)$$

The hypotheses are specified as follows:

H_0 : There is no cointegration or long run relationship

H_1 : There is cointegration.

Two sets of critical values are generated for the bounds test at each significance level – the I(1) values/ upper bound critical values and I(0) values/ lower bound critical values, [23] & [27]. If the F-statistic exceeds the upper bound critical values, then the null hypothesis can be rejected and it can be concluded that there is cointegration among the variables while if the F-statistic is below the lower bound critical values, the null hypothesis cannot be rejected and it can be concluded that there is no cointegration, [25]. If the F statistic is between I(0) and I(1) bounds, the test is inconclusive. The study employed the Akaike information criterion (AIC) to select the optimal lag lengths for the differenced variables in estimating these equations, because it has good small sample properties. AIC and Schwarz Bayesian Criteria (SBC) performs better than the Hannan- Quin criterion (HQC) [19]. However, BIC can be inconsistent and may overestimate lags [28].

- *Error Correction Model*

If co integration is found between the variables, then the short run dynamics can be obtained by constructing the Error Correction Model (ECM) in the ARDL framework as follows [25]:

$$\Delta INFLN_t = \alpha_0 + \sum_{i=1}^{n} \alpha_1 \Delta lnER_{t-i} + \sum_{i=1}^{n} \alpha_2 \Delta lnDOLL_{t-i} + \sum_{i=1}^{n} \alpha_3 \Delta lnEC_{t-i} + \sum_{i=1}^{n} \alpha_4 \Delta lnTOP_{t-i} + \sum_{i=1}^{n} \alpha_5 \Delta lnINFLN_{t-i} + \alpha_6 ECT_{t-i} + \mu_t \quad (5)$$

where ECT_{t-1} is the error correction term, obtained by making it the subject of the formula from equation 1. These coefficients explain the short run relationships between the variables. The coefficient of ECT_{t-1} captures the speed of adjustment towards long-run equilibrium, that is, variations due to shocks to the system are temporal and the system moves towards a long run equilibrium state. There is a negative and statistically significant coefficient on the ECT term which signifies the existence of a long term relationship between variables [25].

- Granger Causality Test (GCT)

The Granger causality test (GCT) is used in conjunction with the ECM specified above, [23] and is used to support the short run analysis. The GCT is used to establish the direction of causality and forecasting strength of the shocks based on other variables, [25]. Considering variables W_t and Z_t, if historical observations of W_t significantly contribute to predicting Z_t, W_t is said to Granger cause Z_t, [23]. The converse relationship can also be established. The GCT is based on the following hypotheses [23]:

$H_0 : W_t$ does not Granger cause Z_t

$H_1 : W_t$ Granger causes Z_t

The above hypotheses are tested using the following regressions, [23].

$$Z_t = a_0 + \sum_{i=1}^{k} a_{1i} Z_{t-i} + \sum_{i=1}^{k} b_{1i} W_{t-i} + \varepsilon_t \quad (6)$$

$$W_t = b_0 + \sum_{i=1}^{k} a_{2i} Z_{t-i} + \sum_{i=1}^{k} b_{21i} W_{t-i} + \mu_t \tag{7}$$

where ε_t and μ_t are random processes and k denotes the number of lagged variables. H_0 is rejected if b_{1i} are jointly significant [23].

- *Post Estimation Model Test*

It is a requirement of the ordinary least squares (OLS) technique that the residuals are homoscedastic and there is no serial correlation in the model residuals. The presence of heteroscedasticity or unequal variance and autocorrelation will give false results, [21]. This study employed the Breusch-Godfrey (BG) Test for second order autocorrelation among variables and first order autocorrelation was checked using the Durbin Watson (DW) Test. The best way to deal with autocorrelation is to replace the variable with an alternative proxy or completely eliminating the variable, [21]. In addition to these two tests, the cumulative sum of squares (CUSUM) test of the residuals was employed for model stability. For the latter, if the plot of the residuals is inside the 5% significance levels, this means the parameters were stable over the period while the opposite is true if the plot of the residuals falls outside the significance levels, [25].

Model validity tests such as the F-test, R-squared, and adjusted R-squared were also analysed as suggested by [29]. R-squared is used to check goodness of fit and the higher the R- Squared value, the better the model. The R-squared coefficients sometimes increase with increases in the number of explanatory variables hence the need to use the adjusted R-squared value for quality checking, [21].

III. Analysis and Results Discusion

- Correlation Matrix and Variance Inflation Factor Test

Table 3: Correlation Matrix

Variables	INFLN	EXCH	Doll	TOP	EC
INFLN Pearson Correlation	1				
Sig(1-tailed)					
EXCH Pearson Correlation	-0.382**	1			
Sig(1-tailed)	0.009				
DOLL Pearson Correlation	-0.437**	0.704**	1		
Sig (1-tailed)	0.003	0.000			
TOP Pearson Correlation	0.024	0.280*	0.032	1	
Sig(1-tailed)	0.443	0.045	0.425		
EC Pearson Correlation	-0.045	-0.177	0.401	-0.250	1
Sig(1-tailed)	0.393	0.144	0.006	0.065	

Source: Authors Calculations

*. Correlation is significant at the 0.05 level (1-tailed).

**. Correlation is significant at the 0.01 level (1-tailed).

As shown in Table 3 above, all the absolute correlation coefficients are less than 0.8 and this implies that there is no multicollinearity among variables [21]

Table 4: VIF test

Model	Collinearity Statistics	
	Tolerance	VIF
Exchange rates	.239	4.190
Dollarisation	.215	4.644
Trade Openness	.866	1.155
EC	.420	2.381

Source: Authors Calculations

If 0<VIF<5, there is no evidence of a multicollinearity problem. If 5<VIF<10, there is moderate multicollinearity problem. If VIF>10, there is serious multicollinearity problem of variable.VIF used to diagnose if there data has no multicollinearity problems. The researcher examined the VIF values to assure of the absence of multicollinearity. From the table above, we can see that VIF<5 for all regressors which implies absence of multicollinearity problem.

- *Unit Root Testing*

Stationarity was tested using the Augmented Dickey-Fuller tests with Intercept and Trend and intercept. A summary of the stationarity results are presented in table 5 below.

Table 5: Unit Root Test Results

Variables	Intercept			Trend and Intercept		
	Level	1st Diff	Order of Integration	Level	1st Diff	Order of Integration
INFLATION	-2.5666	-7.0143***	I(1)	-2.8437	-6.9311***	I(1)
EXCHANGE RATES	0.11189	-4.6343***	I(1)	-3.05412	-4.7420***	I(1)
TRADE OPPENNESS	-2.13811	-8.7390***	I(1)	-0.99694	-6.0518***	I(1)
ECONOMIC GROWTH	-2.5996*	-4.999***	I(0)	-2.5441	-4.9102***	I(1)
DOLLARISATION	-0.5199	-6.000***	I(1)	-1.7488	-6.0631***	I(1)

*Note: The superscript * and *** denotes statistical significanceat 1% and 10% level respectively.*

Table 5 above indicates that all the variables are I (1) from the Augmented Dickey-Fuller test at Intercept and at Trend and Intercept. This suggests that an ARDL approach is the appropriate method of estimation of the relationship since the variables are of I(1) and I(0).

- Optimal Lag Selection

The ARDL bounds test methodology as established by [22] involves use of an appropriate lag length in dataset to eliminate any serial correlation. The optimal order of lag length has been chosen by determining the 1st difference of the conditional ECM of the time series ARDL. There are many criteria for selecting the order of adequate lag length, but the most important criteria among them are the Akaike Information criterion (AIC) and Schwarz Information criterion (SC). In this research, the optimal lag is selected based on the minimum value of AIC.

Table 6: Selected lag length for variables

VARIABLES	LAGS
INFLATION	4
EXCHANGE RATES	4
DOLLARISATION	1

TRADE OPENNESS	**2**
ECONOMIC GROWTH	**0**

- Cointegration Tests

In the event that two or more variables in a time series have a long run relationship between them, cointegration is said to exist [30]. If the residual is stationary and at 5% significance level it is found that the ADF statistic is greater than the critical value, it implies that there is no unit root and hence the variables are cointegrated and also if the ADF statistic is less than the critical value, it implies that there is unit root and hence the variables are not cointegrated. The cointegration test results are presented below.

Table 7: ARDL Bounds Test for Cointegration (4, 4, 1, 0, 2)

Variables	**F- Statistics**	**Conclusion**
F(INFLTN/EXC/TOP/DOLL/EC	**1.507782**	**No Cointegration**
K	**4**	
Critical value	**I(0) Bound**	**I(1) Bound**
10%	**2.45**	**3.52**
5%	**2.86**	**4.01**
2.5%	**3.25**	**4.49**
1%	**3.74**	**5.06**

Source: Authors calculation

Table 7 indicate the calculated F-Statistic and its critical values at 1%, 2.5%, 5% and 10% significance level in both polar extremes, that is at level I(0) and at first difference I(1). The results shows that the F-Statistic computed value which is 1.507782 falls below the upper bound I (1) and less than 4.01 of the F-test critical value at 5% significance level given by [22], and hence we fail to reject the null hypothesis and conclude that there is no long run relationships between variables that is inflation is not cointegrated with exchange rates, dollarisation, trade openness and economic growth.

- Error Correction Model

Table 8: Short run model estimates

VARIABLES	COEFFICIENT	STD. ERROR	t-STATISTIC	PROBABILITY
C	2.326681	1.889394	1.231443	0.2340
D(inflation(-1))	0.850260	0.268737	3.163907	0.0054
D(inflation(-2))	0.000247	0.153249	0.001611	0.9987
D(inflation(-3))	0.475333	0.14863	3.197917	0.0050
D(exchange rates)	-1.641203	1.643698	-0.998482	0.3313
D(exchange	7.742266	1.999097	3.872882	0.0011

rates(-1))				
D(exchange rates(-2))	-8.380979	2.329176	-3.598259	0.0021
D(exchange rates(-3))	8.963462	2.334390	3.839744	0.0012
D(Dollarisation)	-26.94969	15.49609	-1.739128	0.0991
D(trade openness)	-0.053139	0.198600	-0.267569	0.7921
D(trade openness(-1))	-0.449445	0.1693926	-2.741761	0.0134
CointEq(-1)*	-0.805214	0.265266	-3.035494	0.0071

R^2	0.790491
Adjusted R^2	0.685736
F-Statistic	7.546123
Prob(F-Statistic)	0.000033
Akaike info criterion	7.458722
Durbin-Waston stat	2.029102

Source: Authors calculation

From the above table, coefficient of economic variable with D indicates the short run elasticity estimates or short run coefficients. Results suggest that inflation rate lagged first and third period are statistically significant at 5% level of significance. This situation emphasizes the importance of inflationary expectations in the Zimbabwean economy. The results evidence shows that when exchange rates of the previous and third lagged period increases, the inflation rate increases by 7.74% and 8.96% respectively. Furthermore the results shows that exchange rates of the second lagged period also affect inflation rates that is a 1% depreciation of exchange rates decreases inflation by 8.38%.On the other side a 1% increase in dollarization reduces inflation by 26.95%. Furthermore the results suggest that trade openness lagged one period is statistically significance at 5% level of significance. Indicating that 1% increase in trade openness in the previous period will decrease the current inflation rate by 0.45%.The last term in the above table CointEq (-1) is the one period lag error of ECM and is called equilibrium residual of one period lag. The results confirms the negative sign of CointEq(-1) (lagged ECM) and is found to be statistically significant at the 1% level of significance which gives validity to the existence of equilibrium linkage among the particular macro variables. Nevertheless, the speed of adjustment from prior year's disequilibrium in inflation rates is 80.52% annually.The coefficient of determination R^2 is 0.790491. The results above shows about 79% of variation in inflation is caused by variations in the explanatory variables. This shows that the model is of good fit since more than half of the variations are explained within the model. Furthermore, the F-test probability is 0.00033 implying that the whole model is valid at 5% level of significance. The Durbin-Watson (D-W) calculated value is 2.029102 and the region of no autocorrelation as [1.707; 1.9876] at 1% level. The inconclusive region is [1.9876; 2.293] therefore we can conclude that there is no evidence regarding the absence of positive first-order serial correlation [30].

- Granger Causality Test

Table 9: Pairwise Granger Causality Tests

Null hypothesis	Observation	F-Statistics	Prob.	Decision
EXCH does not Granger cause INFLN	36	8.20417	0.0014	Reject
INFLN does not Granger cause EXCH		12.2889	0.0001	Reject
DOLL does not Granger cause INFLN	36	0.45270	0.6400	Accept
INFLN does not Granger cause DOLL		0.79720	0.4596	Accept
EC does not Granger cause INFLN	36	0.33441	0.7183	Accept
INFLN does not Granger cause EC		1.58752	0.2206	Accept
TOP does not Granger cause INFLN	36	0.04113	0.9598	Accept
INFLN does not Granger cause TOP		0.11238	0.8941	Accept
DOLL does not Granger cause EXCH	36	1.33443	0.2780	Accept
EXCH does not Granger cause DOLL		1.46240	0.2472	Accept
EC does not Granger cause EXCH	36	0.23426	0.7925	Accept
EXCH does not Granger cause EC		0.04348	0.9575	Accept
TOP does not Granger cause EXCH	36	1.83102	0.1772	Accept
EXCH does not Granger cause TOP		1.30971	0.2844	Accept
EC does not Granger cause DOLL	36	3.588881	0.0396	Reject
DOLL does not Granger cause EC		3.33673	0.0487	Reject
TOP does not Granger cause DOLL	36	6.26465	0.0052	Reject
DOLL does not Granger cause TOP		1.05142	0.3616	Accept

From the table above, it can be found that exchange rates and inflation P values are less than 0.05 and can be concluded that Inflation granger cause Exchange rates and Exchange rates granger cause inflation hence there is a bidirectional granger causality relationship in the short run. Similarly, for economic growth and dollarization, a bidirectional Granger causality relationship is also found, since the probability of the F-statistic is less than 0.05. In context of Trade openness and dollarisation it can be concluded that the hypothesis that trade openness does not granger cause dollarisation is rejected but the hypothesis that dolarisation does not Granger Cause trade openness is not rejected hence there exists a unidirectional relationship between variables in the short run.

- More Post Results Diagnosis

Table 10: Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-Statistic	**1.254290**	**Prob. F(6,25)**	**0.3201**
Obs*R-squared	**17.37605**	**Prob.Chi-Square(6)**	**0.2969**
Scaled explained SS	**5.260659**	**Prob.Chi-Square(6)**	**0.9897**

•

Using the Breusch-Pagan-Godfrey test, the results obtained in Table 4.8 above strongly supported the null hypothesis that the errors are homoscedastic. The probability value was 0.2969 greaterthan 0.05 and this implies that we accept the null hypothesis and conclude that errors are homoscedastic.

IV.CONCLUSION

The ARDL procedure to cointegration has been applied to establish the long run relationship between all variables included in this empirical study. The results indicated that there exists a short run correlation between inflation, exchange rate, dollarisation, gross domestic product and trade openness. These results are in line with studies of [31], [32], [33] and [34] which concluded a positive relationship between exchange rate and inflation rate. This paper recommends that the government should consider phasing out the bond note and adopt the South African Rand as the main currency for the simple reason that Zimbabwe conducts most of its trade with South Africa and receive funds from expatriate Zimbabweans residing in South Africa. This will also prove not only natural but also strategic as Zimbabwean will be able to negotiate its entry into the Common Monetary Area with greater tranquility. Entry into the CMA will help reduce the impact of exchange rates on inflation in Zimbabwe.

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