Asymmetrical Effects of Real Exchange Rate Volatility during Covid-19 Pandemic on the Demand for Money in Zimbabwe

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Abstract

The understanding of symmetrical or asymmetrical effects of exchange rate volatility improves the effectiveness of macroeconomic management policies. This study examines the long-run asymmetrical effects of exchange rate volatility on real demand for money in Zimbabwe, using monthly data from January 2018 to September 2020. Exchange rate shocks are calculated by decomposing exchange rate volatility measure into positive and negative components to examine their short-run and long-run effects and to determine whether the long-run effects of the components of exchange rate movements are symmetrical or asymmetrical. The linear ARDL and the non-linear ARDL models are estimated. The study employs the F-bounds test to confirm the long-run relationship and the Wald test for the asymmetrical effect. The results show that exchange rate depreciation in Zimbabwe has symmetrical effects on real demand for money. Thus, exchange rate policies in Zimbabwe should assume linearity in the pass-through effects on real demand for money.

Keywords: asymmetrical exchange rate, economic uncertainty, Covid-19, money demand stability

JEL Classification: E41; E52; E6

Introduction

Developing countries struggle to manage demand for money, especially when faced with uncertainties. The debate on the demand for money was revived after the Global Financial Crisis of 2007/08 (Eggertsson & Mehrotra, 2014). In addition, the current Novel Coronavirus (Covid-19) has made the debate more critical because of disruptions in trade, movements, and global supply chains, whereby governments have to set up supportive measures and lockdown policies that affect money demand, money supply and economic activity. During the market turbulence brought about by Covid-19, the exchange rate is expected to be unstable due to investors and borrowers hedging a sizeable portion of their currency mismatches. This may have a pass-through effect on the demand for money (Corsetti et al., 2020).

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The exchange rate influences business decisions and the competitiveness of the domestic traded goods sector; thus, it has pass-through effects on the demand for money. Volatility in the exchange rate can translate into an unstable money demand function. Money demand stability helps to design and implement monetary policy as it predicts the effect of a given amount of money supply on the aggregate economy (Friedman & Schwartz, 1982; Kayongo & Guloba, 2018).

Mundell (1963) once proposed that the exchange rate was a major determinant of money demand, although the proposition was without empirical support. This was followed by a proliferation of the literature that tested and reported significant and insignificant effects of exchange rate on the demand for money. Using data sets of different countries, some studies have validated that asymmetrical effects of exchange rate have been found to be significant, which had been found to be insignificant in the former literature in the symmetrical settings.

The exchange rate has two types of movements: an appreciation[1] and depreciation[2], and it does not follow that any of the movements has the same magnitude or same direction of effects on the demand for money. For instance, one movement can result in bi-directional effects on money demand, that is, both positive and negative effects that are of different magnitude. If this were to be the case, the effects would be regarded as asymmetrical. However, if the magnitude of the direction of the effects is the same (or unidirectional), then the effects would be symmetrical. The global empirical literature on asymmetrical effects of the exchange rate is very sparse, mostly on developing countries such as Zimbabwe.

The exchange rate movements may have positive or negative effects on the demand for money, which raise the problem of asymmetrical effects. For instance, an appreciation of a foreign currency increases the domestic value of foreign assets and people may sell their foreign assets/currency for a capital gain. In this case, local money demand may be increased. This relationship is known as the *wealth effect* (Arango & Nadiri, 1981). On the contrary, an appreciation of a foreign currency may develop the expectations of further appreciation. In this case, economic agents may hold or buy more of the foreign currency in their portfolios for speculative purposes. As a result, demand for the local currency may decrease, which is known as the *substitution effect* or an *expectation hypothesis* (Bahmani-Oskooee & Pourheydarian, 1990). Thus, a single foreign currency appreciation may either increase the local money demand or do the opposite, with the resulting effect being an empirical issue.

Exchange Rate Dynamics and Demand for Money in Zimbabwe

The Zimbabwean currency regime changed, following the introduction of the ZWL Dollar through the pronouncement of the Statutory Instrument 33/2019, which stated that the bond notes and coins were at "par" with the United States Dollar

[1]Appreciation is an increase in the value of one currency in relation to another currency.
[2] Depreciation is a fall in the value of a currency in terms of its exchange rate versus other currencies.

(USD). This had a negating impact of the money demand as the USD crowded-out the bond notes and coins, which led to the Zimbabwean Government to pursue a partial flexible exchange rate regime in February 2019 from a fixed Zimbabwean Dollar (ZWL) of ZWL2.50:USD1 rate (Sakarombe & Makoni-Marimbe, 2020). In this exchange rate regime, it was argue that the price of the ZWL against the USD was determined by the market forces of demand and supply, but could not converge on the parallel market rate. The failure to converge raised concerns that the so-called market determined exchange rate could not be so freely determined as to achieve a Walrasian equilibrium. A Walrasian equilibrium is a perfectly determined market condition in which a hypothetical umpire is assumed. The continued divergence between the official exchange rate and the parallel market rate increased economic instability.

In April 2020, the Reserve Bank of Zimbabwe (RBZ) revised the official exchange rate by fixing it at ZWL25:USD1. However, as the Covid-19 in Zimbabwe continued to disrupt business activities in 2020, the interbank rate was moved to an advanced stage of a free-market condition, which was to be determined through the Dutch auction system. On 23 June 2020, the Dutch auction system was introduced, whereby the exchange rate was designed to be determined through market forces. Consequently, the ZWL depreciated by more than 200 percent against the USD, from ZWL25.00 in May 2020 to ZWL82.00 by October 2020. The RBZ considered this depreciation to have been triggered by the creation of phantom money by the largest mobile money provider in the country and trading activities in the informal market. The question is whether such depreciation tendencies are symmetrical or asymmetrical.

In the Mid-term Monetary Policy Statement (MPS), the RBZ reported that from the introduction of the auction system on 23 June 2020, a total of US$137.4 million had been allotted against bids for US$157.8 million at the end of the ninth auction on 18 August 2020. Hence, the auction system had (during the period under review) served 87.1% of the formal foreign exchange market demand (RBZ, 2020). The Bank stated that the demand for money (local currency in terms of cash balances) was becoming highly insatiable. Nevertheless, in a bid to address that insatiable demand, the bank responded to the increasing demand for cash by the transacting public, by introducing higher denominations of ZW$10 and ZW$20 in the banking system. In addition, the cash withdrawal limits were reviewed upwards from ZWL$300 to ZWL$1000 per week to provide transactional convenience to the public (RBZ, 2020).

This study assesses the symmetrical and asymmetrical effects of the exchange rate on demand for money in Zimbabwe. In this regard, it incorporates an economic uncertainty index within the setting of the Covid-19 pandemic to which the uncertainty in the near future is attributed to. The study covers the period from the first month of 2018 (before flexing the exchange rate) to the ninth month of 2020, a period which incorporates the effects of the changing exchange rate policy. Only a few money demand studies have included economic uncertainty factors in their estimation, such as Bahmani-Oskooee et al. (2013) and Kayongo & Guloba (2018). Thus, this study adds to the scarce literature on the asymmetrical effects of exchange rate on demand for money in Zimbabwe. In addition, the findings of the study aim to contribute to better policy formulation as to augment macro-policy management in Zimbabwe.

Literature Review

Theoretical foundations for money demand are found in Fischer (1911) who determined that demand for money is a function of the level of transactions, and argued that households and businesses demand money to facilitate only transactions. Pigou (1917) further argued that money is held for convenience purposes because it has immediate purchasing power, stores value, and enables people to buy on favourable terms. This can be represented as follows:

$$M_d = f(Py) \qquad (1)$$

Where M_d is the money demand and Py is the nominal income.

Keynes (1935) criticized these previous theoretical stipulations in that they did not include interest the rate as a critical determinant of the demand for money. Hence, he postulated the liquidity preference of money demand, contending that money is held for the transaction, precautionary and speculative motives, whereby the precautionary purpose is affected by the interest rate. On the other hand, Baumol (1952) and Tobin (1956) contended that money held for transaction is also affected by the interest rate. They presented a model that analysed the costs (interest foregone) and benefits (convenience) of holding money. Hence, an individual, decides to build a wealth portfolio that includes money and non-monetary assets. Thus, the money demand model was modified to include the interest rate as follows:

$$M_d = f(Py, IR) \qquad (2)$$

Where IR is the interest rate.

Mundell (1963) proposed the inclusion of the exchange rate, whereas Bahmani-Oskooee (1996) included inflation to incorporate the opportunity cost of holding money. The new money demand function would be as follows:

$$M_d = f(Py, IR, ER, Inf) \qquad (3)$$

Where ER is the exchange rate and Inf is the rate of inflation.

However, Friedman (1956) concluded that economic agents hold a certain quantity of real money as opposed to nominal money balances, since inflation erodes the purchasing power of money. Hence, a model that takes into account Friedman's view accounts for the effect of inflation on money demand, which gives the following model:

$$\frac{M_d}{P} = f(Py, IR, ER, Inf) \qquad (4)$$

According to Bahmani-Oskooee (2019), inflation may be used as an opportunity cost of money holding instead of interest rate in lesser developed financial markets, such as Zimbabwe.

In general, all theoretical specifications of money demand point to the general specification that money demand is a function of a scale variable (national income) and opportunity cost variables (other variables).

Several studies on money demand in Zimbabwe (Kadenge, 1998; Kwashirai, 1999; Munoz, 2006; Makochekanwa, 2007; McIndoe-Calder, 2009) did not consider the exchange rate variable except Kadenge (1998) and they did not test for the asymmetrical effects. Tuluzawu (2016) included the exchange rate in modelling the demand for money but found its coefficient to be insignificant. This study adds to the scanty literature on the exchange rate and money demand in Zimbabwe.

Worldwide, there is growing literature on exchange rate asymmetrical effects. Some African studies support stable demand for money that emanates from exchange rate changes, without checking for asymmetrical effects in cases of Tanzania by Randa (1999), Cote d'Ivoire by Fielding (1999), Nigeria by Anoruo (2002), South Africa by Nell (2003), and Ethiopia by Sterken (2004). Elsewhere, asymmetrical effects were specifically tested by Shin et al. (2014), who applied a nonlinear ARDL approach and found that in both Australia and Japan, exchange rate changes have both short-run and long-run asymmetrical effects on each country's domestic production. Using the same methodology, Bahmani-Oskooee & Mohammadian (2018) confirmed asymmetrical effects in several emerging economies using quarterly data.

Bahmani-Oskoeeet al. (2019) found specifications of asymmetrical exchange rate tendencies on money demand in Asia, specifically in India, Indonesia, Korea, and the Philippines. Further, Bahmani-Oskooee & Gelan (2019) showed that exchange rate changes had short-run effects in 16 African countries of the 18 countries that they studied. Additionally, exchange rate effects were asymmetrical in 11 countries among the 16 countries analysed. Mahmood & Alkhateeb (2018) found symmetrical effects in the short run only for a study on South Arabia. All these studies used a non-linear ARDL model.

Methodology

The estimation of money demand follows the reviewed literature and money demand modelling. The chosen variables include real income as a scale variable, and real exchange rate and inflation as the opportunity cost variables, with the model specified as follows:

$$ln\left(\frac{M_d}{P}\right)_t = \alpha_0 + \beta_1 lnRY_t + \beta_2 Inf_t + \beta_3 lnER_t + \beta_4 EV_t + \varepsilon_t \quad (5)$$

Where M_d/P represents the real money balances; RY represents real income; Infrepresents inflation; ER represents real exchange rate; and EV represents the economic uncertainty variable.

The study excluded the interest rate variable because in the period under review interest rates were constant at a maximum of 12 percent for savings and 18 percent for lending. This constant series caused econometric problems; hence, it was dropped. Following Bahmani-Oskooee (2019), the inflation variable was adopted to replace the interest rate variable.

ln is the natural logarithm transformation, and ε is the error term, which assumes that $\varepsilon \sim (0, \sigma^2)$. β_1 is expected to be positive because of the transaction motive of holding money; β_2 is expected to be negative because money loses its purchasing power in the presence of inflation; β_3 and $\beta_4$can either be positive or negative. t is the time subscript. Money demand estimation is estimated in a log-linear form as shown in Equation 5 above. However, inflation is not logged because it has negative figures and the economic uncertainty variable is not log linearized because it is an index.

The economic uncertainty index (EV) was calculated using Generalized Autoregressive Conditional Heteroscedasticity (GARCH) methods. It is extracted from the volatilities of critical money demand determinants, such as national income, exchange rate, inflation, interest rate spread, foreign interest rate, and a financial innovation proxy (currency outside banks). To generate the volatility series, the above Model 5 without EV was estimated then errors were saved to estimate the following processes:

$$\delta_t^2 = w + \alpha_1 \varepsilon_{t-1}^2 + \beta_2 \delta_{t-1}^2 \qquad (6)$$

Equation 6 represents the estimable variance series being explained by squares of past errors and past variances. δ_t^2 (Conditional variance) is one period ahead of forecast variance based on past information. w is a constant term; ε_{t-1}^2 (ARCH term) is information about volatility from the previous period measured as a lag of squared residual from the mean equation. δ_{t-1}^2 (GARCH term) is the last period forecast variance. The (1,1) in the GARCH refers to the presence of the first-order autoregressive GARCH term and the first-order moving average ARCH term. An ARCH model is a special case of GARCH specification in the form of GARCH (0,1).

Additionally, by adding the lagged ε_t^2 terms to both sides of the above equation and moving δ_t^2 to the right-hand side, the GARCH (1,1) model can be rewritten as an ARMA (1,1) process for the squared errors.

$$\varepsilon_t^2 = \alpha_0 + (\alpha_1 + \beta_1)\varepsilon_{t-1}^2 + v_t - \beta_1 v_{t-1} \qquad (7)$$

Where $v_t = \varepsilon_t^2 - \delta_t^2$

GARCH (1,1) is termed stationary in variance if $\alpha_1 + \beta_1 < 1$. This is the case where the unconditional variance of ε_t is constant and given by the following equation:

$$var(\varepsilon_t) = \frac{\alpha_0}{1 - (\alpha_1 + \beta_1)} \qquad (8)$$

Estimating Equation 6 created (δ_t^2) conditional variances, which represented economic variances that could affect demand for money in an economy as Equation

6 is a product of residuals in the presumed money demand. This process generated EV series that were used as indexes for economic uncertainty in Equation 5.

Equation 5 was estimated using the Autoregressive Distributed Lag (ARDL) method. The ARDL model is a dynamic single regression equation used to predict values of the dependent variable, based on both the current values of the explanatory variable and the lagged values of the explanatory variable. The method can simultaneously estimate both short-run and long-run coefficients; is relieved of the integration order; is more relevantly applied on a small sample, and can be applied on variables of the differing optimal number of lag length. Additionally, before the estimation was undertaken, the study explored some properties of the time series using unit root tests and correlation analysis, since ARDL is only estimated if none of the variables is integrated of order 2, that is, $I(2)$.

The ARDL specification requires that all variables be endogenous, as presented below:

$$\Delta ln\left(\frac{M_d}{P}\right)_t = \alpha_0 + \sum_{j=1}^{p} \theta_j \Delta ln\left(\frac{M_d}{P}\right)_{t-j} + \sum_{j=0}^{q} \vartheta_j \Delta lnRY_{t-j} + \sum_{j=0}^{q} \varphi_j \Delta Inf_{t-j} + \sum_{j=0}^{q} \tau_j \Delta lnER_{t-j} + \sum_{j=0}^{q} \omega_j \Delta EV_{t-j} + \beta_0\left(\frac{M_d}{P}\right)_{t-j} + \beta_1 lnRY_{t-j} + \beta_2 Inf_{t-j} + \beta_3 lnER_{t-j} + \beta_4 EV_{t-j} + \varepsilon_t \qquad (9)$$

Short-run effects are captured by the differenced terms, whereas the variables in their levels capture the long-run effects. The F-test is used to test for the presence of a long-run relationship, since it determines the joint significance of lagged levels of the variables involved. The two sets of asymptotic critical values for the F-test developed by Pesaran et al. (2001) are the lower critical bound and the upper critical bound. The lower critical bound assumes that all the variables are integrated of order zero I (0); hence, there is no cointegrating relationship between the examined variables. However, the upper bound assumes that all the variables are integrated of order one I (1), which means that there is cointegration among the variables. If a long-run cointegrating relationship is established, then an error correction model has to be estimated to determine the short-run coefficients. The specifications of an ARDL error correction model is given below:

$$\Delta ln\left(\frac{M_d}{P}\right)_t = \alpha_0 + \sum_{j=1}^{p} \theta_j \Delta ln\left(\frac{M_d}{P}\right)_{t-j} + \sum_{j=0}^{q} \vartheta_j \Delta lnRY_{t-j} + \sum_{j=0}^{q} \varphi_j \Delta Inf_{t-j} + \sum_{j=0}^{q} \tau_j \Delta lnER_{t-j} + \sum_{j=0}^{q} \omega_j \Delta EV_{t-j} + \pi_4 ECT_{t-1} + \varepsilon_t \qquad (10)$$

1

The residuals from the estimation of the long-run model (9) are used to derive the error correction term (ECT).

In estimating the linear ARDL model (Equation 10), we assume that all the variables have symmetrical effects on monetary aggregates, which means that, exchange rate appreciation may raise money demand, whereas exchange rate depreciation may lower money demand. However, the symmetrical effect may not necessarily be the case, since the opposite, the asymmetrical scenario may happen. Thus, to test the asymmetrical hypothesis, changes in the real exchange rate variable ($lnER$) are constructed to come up with ($\Delta lnER$). In these series ($\Delta lnER$), the positive exchange rate is denoted as $\Delta lnER^{+ve}$and the negative exchange rate is denoted as $\Delta lnER^{-ve}$. Hence, two new time series would be created, those with positive notation and those with negative notation. These series are defined as the partial sum of the negative and positive changes. Using the exchange rate adopted, positive shocks represent a depreciation of the Zimbabwean dollar against the US dollar, whereas negative shocks represent an appreciation.

$$PER_t = \sum_{j=1}^{t} \Delta lnER_j^{+ve} = \sum_{j=1}^{t} max(\Delta lnER_j, 0) \qquad (11)$$

$$NER_t = \sum_{j=1}^{t} \Delta lnER_j^{-ve} = \sum_{j=1}^{t} min(\Delta lnER_j, 0) \qquad (12)$$

Replacing ($lnER$) in equations 9 and 10 by (PER) and (NER) gives the non-linear ARDL specifications, summarized as follows:

$$\begin{aligned}\Delta ln\left(\frac{M_d}{P}\right)_t = \alpha_0 &+ \sum_{j=1}^{p} \theta_j \Delta ln\left(\frac{M_d}{P}\right)_{t-j} + \sum_{j=0}^{q} \vartheta_j \, \Delta lnRY_{t-j} + \sum_{j=0}^{q} \varphi_j \, \Delta Inf_{t-j} \\ &+ \sum_{j=0}^{q} r_j \, \Delta lnPER_{t-j} + \sum_{j=0}^{q} s_j \, \Delta lnNER_{t-j} + \sum_{j=0}^{q} \omega_j \, \Delta EV_{t-j} + \beta_0 \left(\frac{M_d}{P}\right)_{t-j} \\ &+ \beta_1 lnRY_{t-j} + \beta_2 Inf_{t-j} + \beta_3 lnPER_{t-j} + \beta_4 lnNER_{t-j} + \beta_5 EV_{t-j} \\ &+ \varepsilon_t \qquad (13)\end{aligned}$$

$$\begin{aligned}\Delta ln\left(\frac{M_d}{P}\right)_t = \alpha_0 &+ \sum_{j=1}^{p} \theta_j \Delta ln\left(\frac{M_d}{P}\right)_{t-j} + \sum_{j=0}^{q} \vartheta_j \, \Delta lnRY_{t-j} + \sum_{j=0}^{q} \varphi_j \, \Delta Inf_{t-j} \\ &+ \sum_{j=0}^{q} r_j \, \Delta lnPER_{t-j} + \sum_{j=0}^{q} s_j \, \Delta lnNER_{t-j} + \sum_{j=0}^{q} \omega_j \, \Delta EV_{t-j} \;{}_1 + \pi_4 ECT_{t-1} \\ &+ \varepsilon_t \qquad (14)\end{aligned}$$

The models present three asymmetries, namely, the short-run, adjustment, and long-run asymmetries. The Wald test was used to test for the null hypothesis of symmetry.

The data used were monthly from January 2018 (a year before the floating of the exchange rate, which allowed for the capturing of different specific-time-policy effects in exchange rate volatility) to September 2020 (due to availability of the data). The data on all variables were collected from the Reserve Bank of Zimbabwe, except for GDP which was collected from the Ministry of Finance 2021 National Budget Statement. The GDP data were spliced to match the monthly series intervals.

Results and Discussion

The descriptive statistics of the variables employed by the study are presented in Table 1. The table shows that the mean inflation rate (INF) is 11.98 while the average exchange rate (ER) is 14.751. The average Real money demand (MD is Z$20084706.665 and the average Real Income (RY) is Z$19039651515.151. Economic shocks represented by EV average to 2764899584829407. Taking into account that the values of the standard deviation of the respective variables are largely greater than their respective means (averages), it implies that the distributions of each series are far from their respective means; hence, the sample is not normally distributed. This is confirmed by the Jarque-Bera statistics, whose corresponding probabilities are mostly close to zero.

Table 1: Descriptive Statistics

	MD	ER	EU	INF	RY
Mean	20084706.665	14.751	2764899584829407	11.983	19039651515.151
Median	2927867.685	5.263	514962983499284	9.200	18914500000
Maximum	272363566.000	82.25	26231090362334800	39.260	20235000000
Minimum	371783.569	1.000	60814958221992.6	-0.250	18236000000
Std. Dev.	50845224.893	22.126	5359147927769055	11.879	574860757.013
Skewness	4.050	2.145	3.134432705931779	0.892	0.570
Kurtosis	19.848	6.727	13.10659038272035	2.884	2.231
Jarque-Bera	480.494	44.411	194.4825337347128	4.396	2.598
Probability	0.000	0.000	0	0.111	0.273
Sum	662795319.944	486.768	91241686299370400	395.430	628308499999.999
Sum Sq. Dev.	82727580621066300	15665.981	9.190549283747632e+32	4515.896	10574876478535400000
Observations	33	33	33	33	33

The correlation results among the variables are shown in Table 2. There exists a positive relationship between income and money demand. This also applies to the correlations between money demand and economic uncertainty, although it is weak. This relationship is as expected because theories of money demand postulate a positive relationship between money demand and economic activity. However, the relationship between money demand and inflation and between money demand and the exchange rate is negative.

Table 2: Correlations Matrix

	EV	INF	ER	MD	RY
EU	1				
INF	-0.435	1			
ER	-0.316	0.302	1		
MD	0.054	-0.356	-0.098	1	
RY	0.547	-0.625	-0.281	0.478	1

Before testing for stationarity, the study logged money demand (LMD). Real income (LRY) and real exchange rate (LER), whereas inflation (INF) and economic uncertainty (EV) were not logged. The results of the stationarity tests are presented in Table 3. The Augmented Dickey-Fuller test was employed, whereby all series were found to be integrated of order one $I(1)$at one percent level.

Table 3: Stationarity Results

Variable	Level	Result	1st Difference	Result
LMD	-2.439 (0.140)	Non-stationary	-7.079*** (0.000)	Stationary
LRY	0.122 (0.996)	Non-stationary	-5.568*** (0.001)	Stationary
LER	0.833 (0.993)	Non-stationary	-4.943*** (0.000)	Stationary
EV	-2.275 (0.186)	Non-stationary	-6.821*** (0.000)	Stationary
INF	-3.030 (0.042)	Non-stationary	-5.253*** (0.000)	Stationary

Note: ***represents statistically significant at 1 percent level, figures in parenthesis are probability.

The Akaike Information Criteria (AIC) was used to select the optimal lag length for estimation. After specifying the linear ARDL (LMD: INF; LER; LRY; EV), the optimal lag length established is (1, 2, 3, 1, 4). On the other hand, the lag length established for the non-linear ARDL (LMD: EV; INF; PER; LRY; NER) is (1, 3,3,3,1,1).

The study used the F-Bounds cointegration test to check for the existence of a long-run relationship between real money demand and its determinants. For both the ARDL and non-linear ARDL models, the bounds test for co-integration revealed the existence of long-run relationship at 1% level, given the F-statistic values of 8.906 and 4.741, which are over the Pesaran critical value of I(1) 5.06 and 4.68 at 1% level of significance, respectively. The results are presented in Table 4.

Table 4: F-Bounds Test Results

Model	Linear ARDL		Non-Linear ARDL	
Test Statistic	Value	K	Value	K
F-Statistic	8.906***	4	4.741***	5
	Critical Value Bounds			
Significance	***I(0) Bound***	***I(1) Bound***	***I(0) Bound***	***I(1) Bound***
10%	2.45	3.52	2.26	3.35
5%	2.86	4.01	2.62	4.18
1%	3.74	5.06	3.41	4.68

Note: ***represents statistically significant at 1 percent level

The results in Table 5 summarizes estimations of the linear ARDL model. The long-run results from the linear ARDL showed that real income and exchange rate are positively related with real money demand in Zimbabwe. On the other hand, economic uncertainty and inflation are negatively related with real money demand in Zimbabwe. As inflation increases, economic agents decrease their demand for money as justified by the decrease in the real value of money balances. The coefficient of economic uncertainty is economically insignificant, although it is statistically significant.

Table 5: The Linear ARDL Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Short-run Results				
D(INF)	-0.0705***	0.0092	-7.6698	0.0000
D(INF)	0.0373***	0.0109	3.4234	0.0045
D(LER)	-0.3924	0.3432	-1.1435	0.2735
D(LER(-1))	0.0988	0.4155	0.2377	0.8158
D(LER(-2))	-1.5669***	0.3653	-4.2892	0.0009
D(LRY)	-90.8808**	31.7801	-2.8597	0.0134
D(EV)	-0.0000***	0.0000	-6.2742	0.0000
D(EV(-1))	-0.0000	0.0000	-0.5468	0.5938
D(EV(-2))	0.0000***	0.0000	3.0367	0.0095
D(EV(-3))	0.0000***	0.0000	4.8659	0.0003
CointEq(-1)	-0.6179***	0.1399	-4.4159	0.0007
Long Run Results				
INF	-0.1593***	0.0278	-5.7212	0.0001
LER	1.6764***	0.3009	5.5705	0.0001
LRY	88.5479***	14.599	6.0655	0.0000
EV	-0.0000***	0.0000	-3.6887	0.0027
C	-2079.0717***	345.2559	-6.0218	0.0000

Notes: ***represents statistically significant at 1 percent level, ** represents 5 percent, while * represents 10 percent level.

The short-run results for the linear ARDL showed that the error correction term is negative and statistically significant. The ECT term is -0.6179, implying that about 62 percent of the disequilibrium in money demand in the long run is corrected with that of the following month. This is a high rate of adjustment towards the equilibrium. Converse to the long-run results, lagged exchange rate has a negative relationship with real money demand. This implies that whenever Zimbabwe's exchange rate depreciates, economic agents tend to reduce their demand for money. This result confirms that expectations affect money demand; that is to say, a weak domestic currency yields expectations for further weakening, which implies that economic agents may be responding by shifting their portfolios to other currencies, which could be appreciating. Inflation has both negative and positive signs in the short run, whereas the sign on real income is not as expected.

The long-run results of the non-linear ARDL model presented in Table 6 are consistent with those of the linear model. Exchange rate shocks (depreciation and appreciation) and real income have a positive impact on real money demand. However, the coefficient of exchange rate appreciation (NER) is statistically insignificant. Similar to the linear model, inflation and economic uncertainty show a negative relationship with the real demand for money, with the coefficient of economic uncertainty being economically insignificant as well.

Table 6: The Non-linear ARDL Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Short-run Results				
D(INF)	-0.0711***	0.0169	-4.2019	0.0030
D(INF)	0.0136	0.0159	0.8579	0.4159
D(PER)	-0.1352***	0.0264	-5.1283	0.0009
D(PER(-1))	-0.0476	0.0621	-0.7665	0.4654
D(PER(-2))	-0.6200***	0.1504	-4.1219	0.0033
D(PER(-3))	-0.9036***	0.1828	-4.9430	0.0011
D(LRY)	325.0201***	83.6524	3.8854	0.0046
D(LRY(-1))	225.5615*	103.5199	2.1789	0.0610
D(LRY(-2))	-45.7935	99.5998	-0.4598	0.6579
D(LRY(-3))	-100.4111	62.3106	-1.6115	0.1457
D(EV)	-0.0000***	0.0000	-5.6381	0.0005
D(EV(-1))	-0.0000	0.0000	-0.9059	0.3914
D(EV(-2))	0.0000*	0.0000	2.1192	0.0669
D(EV(-3))	0.0000***	0.0000	4.1787	0.0031
D(NER)	2.3972	5.7449	0.4173	0.6838
CointEq(-1)	-0.8707***	0.1638	-5.3147	0.0007
Long Run Results				
INF	-0.1074***	0.0313	-3.4341	0.0089
PER	1.8643***	0.2776	6.7160	0.0002
LRY	105.8473***	13.4684	7.8590	0.0000
EV	-0.0000***	0.0000	-4.4788	0.0021
NER	63.1460	67.6306	0.9337	0.3689
C	-1777.1893***	407.0071	-4.3664	0.0024

Notes: ***represents statistically significant at 1 percent level, ** represents 5 percent while * represents 10 percent level.

Furthermore, an exchange rate depreciation of the Zimbabwean dollar against the US Dollar was found to have a positive effect on real money demand, for both the linear ARDL and the non-linear ARDL models, which implies the absence of exchange rate asymmetries on Zimbabwe's money demand. The Wald Test (Table 7) confirms the absence of asymmetrical effects. This absence may be attributed to the lack of appreciation in the exchange rate during the period under study. Thus, any positive movement (depreciation) in the exchange rate may instigate the expectation of the same movement in the future. Consequently, the expectation hypothesis is dominant over the wealth effect for positive movement of the exchange rate, both in the short run and the long run. The exchange rate only appreciated in only one month, which may be the reason why the coefficient of exchange rate appreciation (NER) was found to be insignificant mostly.

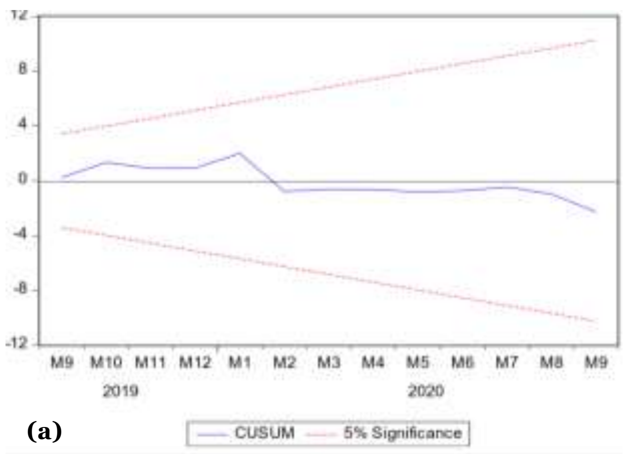
The error correction term for the non-linear ARDL model is shown to depict a higher speed of adjustment to the equilibrium than for the linear ARDL model. The value of -0.8707 implies that Zimbabwe's money demand disequilibrium is corrected for in the following month at a speed of adjustment of 87 percent in the long run.

In the short run, the exchange rate depreciation has a negative impact on money demand, whereas the coefficient for the appreciation of the exchange rate is insignificant. Consistent with the linear model, the signs of the coefficients of inflation, real income, and economic uncertainty did not change. The economic uncertainty term remained economically insignificant in both models.

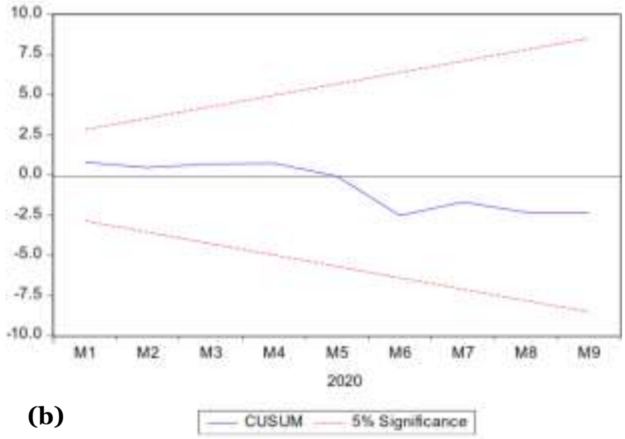
The diagnostic results in Table 7 and the stability results in Figure 1 ((a) and (b)) reflect the goodness of fit of the estimated models. Both models were shown to be satisfactorily specified. The Wald test on the non-linear model confirms the presence of symmetrical effects in exchange rate shocks on the demand for money function for Zimbabwe, both in the short run and the long run. The estimated values of the CUSUM tests in Figure1 were shown to be within the critical values, which implies that the estimated money demand function is stable.

Table 7: Diagnostic Tests

Diagnostic Test	Linear ARDL	Non-Linear ARDL
Adjusted R-squared	0.9356	0.8392
F-Statistic	28.1102 (0.0000)	9.9071 (0.0001)
S.E. of Regression	0.3715	0.6276
Squared Residual Sum	1.7938	4.7259
DW	2.8373	2.2470
J B Normality Test	4.2146 (0.1216)	0.4133 (0.8133)
Breusch-Godfrey Correlation LM Test:	0.4844 (0.6572)	1.1879 (0.3445)
Wald Test – Short run		t= 0.1878 (0.8542)
		F=0.0353 (0.8542)
– Long run		t=-0.2548 (0.8052)
		F=0.0649 (0.8042)



(a)



(b)

Figure 1: ***Stability Results (a) Linear ARDL Model; (b) Non-linear ARDL Model***

Conclusion

The paper has tested the symmetrical and asymmetrical effects of the exchange rate on Zimbabwe's real money demand for the period of January 2018 to September 2020. The paper used the linear ARDL and non-linear methods to estimate the symmetrical effects and asymmetrical effects, respectively. The study incorporated economic uncertainty indicators in the empirical model of the demand for money in Zimbabwe in the face of the novel coronavirus pandemic, which is the first study in Zimbabwe to attempt such modelling. The study found that positive shocks of the real exchange rate (currency depreciation) are symmetrical, whereas an appreciation was found to have an insignificant effect. This finding could be related to the minimum appreciation phases of the local currency during the study period. The economic uncertainty term was found to be statistically significant but economically insignificant in both models. Real income had theoretically consistent positive signs in both models, except for once; however, the sign on the inflation coefficient was inconsistent across the models. The error correction terms for both the linear and non-linear models were negative and significant, with high speeds of adjustment. The estimated model is dynamically stable with no serial correlation. The model predicted no multicollinearity problem, and it was shown to be correctly specified by various post-estimate diagnostic checks. The findings implies that assuming linearity in policymaking and implementation is in line with economic agents' predictions and reactions.

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