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Excessive depreciation of the Zambian kwacha against the US Dollar; firms, households and government; what is the way forward?

Humphrey Fandamu

Abstract
The main aim of the study was to explore possibilities of trading directly with ZMK/YUAN as the Zambian firms and household's trade with China. The study employed the Multivariate cointegration test and Vector autoregressive (VAR) model to analyse the data. The findings indicated that exchange rate variables namely ZMKYUAN, ZMKUSD, ZMKRAND and ZMKFRANC do not have long run relationship among each other in the system of equations. Furthermore, short run results in the VAR system also showed that ZMKUSD and ZMKYUAN do not have short run significant effect on each other. These findings indicates that changes in ZMKUSD do not have long run and short run effect on ZMKYUAN. The implication for Zambian firms and households is that they can avoid cost of appreciation of US Dollar by trading directly with ZMK/YUAN rather than trading with ZMKUSD and later with YUAN/USD as they import goods from China. Therefore, this calls for government to liberalise the transactions in ZMK/YUAN.

Keywords: Exchange rate, multivariate cointegration, vector autoregressive model.

1. Introduction

There has been excessive depreciation of the Zambian kwacha against US Dollar over a decade now and following excessive depreciation of the Zambian kwacha (ZMK) against the US Dollar, firms and households have found it expensive to import inputs and households goods respectively. In addition, projections for the price of US Dollar in terms of the Zambian Kwacha are that the Zambian kwacha is likely to depreciate further against the US Dollar owing to the fact that domestic production, especially in the mining sector whose revenue contributes heavily to stabilising the Zambia kwacha, is likely to reduce due to reduced supply of electricity in Zambia (Mukanga, 2015) [19] and (Kampamba, 2015) [15]. Reduced production in the mining sector implies reduced foreign reserves with a consequent depreciation of the Zambian kwacha. What this means is that firms and households, especially those that are involved in importing are more likely to suffer due to increased cost of importation especially if this cost is not wholly passed across to buyers inform of increased prices. Increased price of imported inputs due to kwacha depreciation will negatively affect efforts of export diversification especially in agriculture and manufacturing sector.

It is important to mention that in the past two decades, there has been increased trade with China (BOZ, 2013) [6]. Actually, most of the intermediate inputs used by firms especially in the manufacturing and agriculture sector and indeed households goods that are traded in the Zambia markets are imported from china. Furthermore, the Zambia government has been running million US Dollar projects in road infrastructure and most of the inputs and labour are imported from China. However, the medium of exchange for importing these inputs is US Dollar. This compounded with reduced foreign earnings from the mining sector may have contributed to putting more pressure on the US dollar leading to further deprecation of the Zambia (Kampamba, 2015) [15].

Since China has become one of the major trading partners of the Zambian economy with most of the finished and intermediates goods being traded in the Zambian market being imported from China, the study seek to suggest that both firms and household may reduce the

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cost effect of kwacha depreciation against the US Dollar, by directly trading with ZMK/YUAN exchange rate other than by first buying the US Dollar with Zambian kwacha and later use the US Dollar to purchase the Chinese Yuan so as to trade with China. The US Dollar could only be used in other transactions that do not involve trade with China. However, avoiding the cost of US Dollar appreciation in the importation of goods in this manner is only achievable if ZMK/YUAN and ZMK/USD do not have a long run relationship with each other. This is because, if the two exchange rates have a long run relationship, they would influence each other and therefore, it would be pointless to trade directly in ZMK/YUAN so as to avoid the cost effect of ZMK depreciation against the US Dollar.

This Paper therefore aims at exploring possibilities of trading directly with ZMK/YUAN as the medium of exchange as Zambia firms and households trade with China. In doing so, the study employs the Multivariate cointegration test and Vector autoregressive (VAR) model for purposes of analysis.

2. Literature

The theory of cointegration suggest that two or more variables would be expected to hold some long run or equilibrium relationship with one another (Chris, 2008) [8]. When variables are cointegrated, it means that they move together over time such that even if they wondered or deviated from each other for some time, they would still get back to their stead state or equilibrium. On the other hand, if series are not cointegrated, they could wonder apart without bound for a long period of time without coming to their stead state. This is because the linear combinations of their series are non-stationary (Chris, 2008) [8]. If variables are cointegrated, short run deviations from equilibrium manifest but are corrected for in the long run. Thus, if for instance, foreign exchange markets are cointegrated, it is possible to have cross exchange rate discrepancies in short run that could allow economic agents to take advantage of temporal deviations and generate excess profits. However, overtime these excess profits are competed away by economic agents. Therefore, financial markets that are cointegrated are inefficient markets because they allow individuals to make excess economic profits (Granjer, 1986) [13]. On the other hand if financial markets are not cointegrated, it means such financial markets do not move together over time and therefore, it is not possible to make excess profits. The implication of cointegration in terms of foreign exchange market is that economic agents cannot diversify when financial markets are cointegrated because such market have a long run relationship with each other. However, if financial markets like exchange rate markets are not cointegrated, economic agents can diversify and protect themselves from risk coming from another foreign exchange market (Chris, 2008)[8]. This is because movement in one exchange rate will not have long run effect another exchange rate.

Michael (2007) [18], carried out a study in which he investigated market foreign exchange market efficiency since the introduction of the Euro by applying the cointegration technique to the exchange rates. He found long run relationship between the following exchange rate pairs; the EUR/USD and GBP/USD. MacDonald and Taylor (1989) [17] did a study in which they examined whether there exist long run relationship between the French Franc/US Dollar and the Deutsche Mark/US Dollar. Their findings showed that the two exchange rates are cointegrated and therefore, have a long run relationship. Bollerslev and Baillie (1989) [1] examined cointegration relationships among seven exchange rates using multivariate approach to cointegration. They too confirmed that there exist cointegration relationships among exchange rates. Lopez (1990) [16] conducted a study in which examination of exchange rates was made regarding whether they were cointegrated or not over different time periods linked to regimes shift in central banks. The study by Lopez (1990) [16] found no evidence of cointegration before regime shift but cointegration was found after regime shift.

There is also a number of authors who in their studies have found no evidence of cointegration among exchange rates. For instance Diebold *et al*. (1994) [12] test for the presence of cointegration among selected exchange rates. They found no evidence of cointegration among selected exchange rates once trend is introduced in the system. Likewise, Copeland (1991) [10] and Coleman (1990) [9] found no evidence of long run relationship among exchange rate variables.

3. Methodology

In examining the multivariate long run relationship among exchange rates, the study made use of Johansen test of cointegration. As explained earlier in literature, this methodology enables us to determine whether the variables being examined have long run relationships among themselves or not.

The Johansen and Juselius Vector Error correction model can be specified as follows as is specified in Chris (2008);

$$\Delta Y_t = \Pi Y_{t-k} + \Gamma_1 \Delta Y_{t-1} + \Gamma_2 \Delta Y_{t-2} + \cdots + \Gamma_{k-1} \Delta Y_{t-(k-1)} + u_t \quad (1)$$

Where $\Pi = (\sum_{i=1}^{k} B_i) - I_g$ and $\Gamma_i = (\sum_{j=1}^{i} B_j) - I_g$ and Δ denotes first difference

This implies that equation (1) is a VAR containing (g) number of variables which are integrated of order one. This VAR contains (g) variables in first difference form on the left hand side and *k*-1 lags of the dependent variables in first difference on the right hand side. The short and long run adjustments to Y are captured by the terms Γ_i and $\prod$ respectively. In other words Γ_i specifies short run relationship between the dependent variable and the other variables in the VAR system while II specifies the long run relationship between the dependent variable and the other variables in the VAR system. The term II =αβ'where (α)denotes vector of error-correction coefficients which measure the speed of adjustment to disequilibrium or simply put;(α)measures the speed of convergence of the variable Y in the VAR to the long run steady state. On the other hand β is the matrix of cointegrating vectors also called the matrix of long run parameters representing cointegrationg or long run relationships. Therefore β ensures that Ys converge to their long run steady state. In simple terms, if for instance Y deviated or wondered from its steady state or its long run equilibrium; the mechanism that will ensure that Y reverts or gets back to its equilibrium is β. On the other hand the mechanism that measures the speed at which Y is converging to its long run equilibrium is (α).

3.1 Estimation procedure

Cointegration methodology requires that all the variables be integrated of same the order. This also entails establishing whether variables are stationary or not. It is very important to establish whether data are stationary because this enables a researcher to know whether a shock to a variable Y_t will be permanent or transient (temporal). Thus for instance if the effect of a shock to Y_t is temporal, it means that though Y_t wonders from its equilibrium as a results of a shock; it will return to its long run equilibrium in the subsequent period. Thus if Y_t return to its equilibrium even after a shock, it means Y_t is stable and stationary. However, if Y_t receives a shock and does not revert back to its long run equilibrium after subsequent period, it means Y_t is not stationary. This implies that the shock to Y_t is absorbed and becomes part of the system. The remedy is to difference it and make it stationary. Data differenced to make them stationary are called integrated series. In order to establish the order of integration, the study employed augmented Dickey Fuller (ADF) tests on variables in levels and first difference. The ADF test is specified as follows;

$$\Delta Y_t = \alpha_o + \delta Y_{t-1} + \sum_{i=1}^{n} \Delta Y_{t-i} + u_t \qquad (2a)$$

Where $\delta = \rho - 1$ therefore the null and the alternative could be written as follows

$$H: \delta = 0 \qquad (2b)$$

$$H: \delta \prec 0 \qquad (2c)$$

Dickey and Fuller (1979) [11] showed that under the null hypothesis of unit root this test statistics does not follow the convectional student t-test distribution. Thus Mackinnon critical value calculations were used to evaluate the null against the alternative hypothesis. If the null hypothesis H: $\delta = 0$ is rejected, we fail to reject the alternative H: $\delta \prec 0$ this means Y_t is stationary and otherwise it is nonstationary.

Several augmentations are made to equation (2a) in order to achieve residuals that are nonserially auto correlated. The selection of the appropriate augmentations or lag length could be determined by Akaike information criterion (AIC) or and Bayesian information criterion (SIC).This is vital because too many lags in a finite sample may reduce the power of the test due to estimation of additional coefficients and loss of degrees of freedom. On the other hand too few lags may not capture the dynamics of the error correction process.

After establishing the order of integration of the variables in the Y_t, the next stage is the test for cointegration using Johansen and Juselius (1990) [14] approach which establishes the presence or absence of cointegrating equations and this entails estimating equation 1. The test for cointegration between Ys in equation 1 is calculated by looking at the rank of Π matrix through examination of its eigenvalues. The rank of the matrix means the number of charecteristics roots (eigenvalues) that are statistically different from zero. Thus to determine the rank of Π which will give the order of cointegration (the number of cointegration relationship), the charecteristics roots or the eigenvalues of Π should be estimated.

There are two statistics for cointegration test under the Johansen approach which are formulated as follows;

$$Q_{trace}(r) = -T\sum_{i=r+1}^{g} \ln(1-\lambda i) \qquad (3)$$

$$Q_{max}(r, r+1) = -T\ \ln(1-\lambda_{r+1}) \qquad (4)$$

Where r = the number of cointegration vectors under the null hypothesis

λ_i= the estimated value of the i^{th} eigenvalue from the rank Π matrix. In equation (3) and (4), the larger the estimated value of λ_i the, the larger the $(1-\lambda i)$ and the larger the test statistic. Each eigenvalue (λ) is associated with a different cointegrating vector, which will be eigenvectors. A statistically non-zero eigenvalue indicates a significant cointegrating vector (Chris, 2008)

Q_{trace} is a joint test with the following hypthothesis;

Ho; there is less than r number of cointegrating vectors

Hi: there are more than r cointegrating vectors

Q_{max} conducts separate test on each eigenvalue with the following hypothesis;

Ho: the number of cointegrating vectors is r

Hi: there are r+1 cointegrating vectors

If the test statistic from either Q_{max} or and Q_{trace} is greater than the critical value provided by Johansen's table or Osterwald (1992) [20], we reject the null hypothesis, and otherwise we cannot reject the null hypothesis.

If Johansen test of cointegration establishes the number of cointegration relationships, then one has to proceed to estimating the Vector Error Correction Model (VECM). However, if test indicates that variables are not cointegration that is, they do not have long run relationship, it is a tradition in econometrics to estimate vector autoregressive (VAR) model in order to examine short run relationships among variables. In addition, the appropriate order of the test VAR can be determined by SIC, AIC or the likelihood ratio test (LR). However, in this model, only AIC was used to determine optimal lag length.

4. Data source and description

This study made use of monthly data of the exchange rates of the Zambian currency (ZMK) against other major currencies. The data ranges from 2007, month of December to 2012, month of February. It is worth mentioning here that, the series should have been longer but it was difficult to get longer series especially the exchange rate of the Zambian currency against the Chinese Yuan. Below is the description of exchange rates

ZMKYUAN= Zambian kwacha (ZMK) against the Chinese currency (YUAN)

ZMKUSD= Zambia kwacha (ZMK) against the United States dollar

ZMKFRANC=Zambian kwacha (ZMK) against the Swiss currency (FRANC)

ZMKRAND=Zambian kwacha (ZMK) against the South African currency (RAND)

These exchange rates were selected because Zambia trades highly trade with Switzerland ranked high followed by South Africa and China (BOZ,2009) [2], (BOZ, 2010) [3, 4], (BOZ, 2011)[5] and (BOZ, 2013) [6].

5. Estimation, Results and Analysis

Estimation began with establishing the order of integration of all the variables. The study made use of the Augmented Dickey Fuller (ADF) test along the SIC to determine the appropriate lag length. The results of the ADF test are tabulated in table 1 below

Table 1: Augmented Dick Fuller Test for Unit Root Test

Variable	Levels		Differenced		
	Adf-Statistics	Critical Values @1%	Adf-Statistics	Critical Values @1%	Order Of Integration
Zmkyuan	-1.961913	-3.574446	-4.568630	-3.571310	I(1)
Zmkusd	-2.399428	-3.574446	-4.574949	-3.571310	I(1)
Zmkrand	-0.744989	-3.568308	-5.177963	-3.571310	I(1)
Zmkfranc	-0.959019	-3.568308	-6.348364	-3.571310	I(1)

Results in table1 indicate that all the variables are non-stationary in levels because their respective ADF statistics are less negative than critical values at 1% level of significance. However, when differenced all the variables become stationary. As can be seen in table1, the ADF statistics of the differenced series are more negative than their respective critical values at 1% significance level.The findings of the unit root test indicate that all the variables are integrated of order one since they are non-stationary in levels but become stationary when differenced once.

After establishing the order of integration, the study proceeded to conduct Johansen test of cointegration whose results are tabulated below in table 2. It should be noted that the optimal lag length in the Johansen test for cointegration was chosen based on AIC.

Table 2a: Cointegration Test- Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace - Statistic	0.05 Critical Value	Prob.**
None	0.388374	43.27881	47.85613	0.1259
At most 1	0.196579	19.18872	29.79707	0.4794
At most 2	0.142491	8.463796	15.49471	0.4172
At most 3	0.018827	0.931328	3.841466	0.3345

The trace statistics in table 2(a) indicate that there is no cointegration relationship among ZMKYUAN, ZMKUSD, ZMKRAND and ZMKFRANC since the null hypothesis that there are at most zero cointegration relationships cannot be rejected since the probability of 0.1259 is more than 5%. As can be observed in table 2a, the Eigen value of 03.88374 is smaller than the trace statistics of 43.27881, indicating that we cannot reject the null hypothesis that there are no cointegration relationships among variables. In like manner, the maximum Eigenvalue statistics in table 2(b) also shows that there is no cointegration among variables since we cannot reject the null hypothesis that there is at most zero cointegration equations in the system because the Eigen value of 0.388374 is smaller than the maximum eigenvalue statistics.

Table 2b: Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen statistics	0.05 Critical Value	Prob.**
None	0.388374	24.09009	27.58434	0.1316
At most 1	0.196579	10.72492	21.13162	0.6747
At most 2	0.142491	7.532467	14.26460	0.4282
At most 3	0.018827	0.931328	3.841466	0.3345

5.1 Cointegration Results and Discussion

The results of Johansen and Juselius cointegration test in table 2a and 2b have implications for firms, households and government. Since ZMKYUAN, ZMKUSD, ZMKRAND and ZMKFRANC are not cointegrated, it means that they do not have long run relationship among themselves. This means that movements in one exchange rate does not have long run significant effect on the other exchange rate in the system. Therefore, Changes in ZMKUSD should does not have long run effect on ZMKYUAN and vice versa.What this implies is that, depreciation of ZMK against the US Dollar should not have long run effect on the ZMKYUAN exchange rate. The implication for firms and households is that firms and households may reduce the cost effect of ZMK depreciation against the US Dollar by trading directly with ZMKYUAN when importing goods from or trading with China. This is because there is no cointegration or equilibrium relationship between ZMKUSD and ZMKYUAN.

Having established the absence of cointegration among exchange rates in the system of equations, the author proceeded with Vectorautoregressive (VAR) estimation so as to examine short run relationships among exchange rates. The results for the systems of equations in the VAR are tabulated in table 3 below.

Table 3: Vectorautoregressive Estimates

	Model 1	Model 2	Model 3	Model 4
	D(ZMKYUAN)	D(ZMKUSD)	D(ZMKFRANC)	D(ZMKRAND)
D(ZMKYUAN(-1))	-0.818526	-7.991093	-13.98692	-2.72798*
	(1.56354)	(11.0199)	(13.7218)	(1.55706)
	[-0.52351]	[-0.72515]	[-1.01932]	[-1.75201]
D(ZMKUSD(-1))	0.196925	1.691268	2.325792	0.403732*
	(0.22171)	(1.56260)	(1.94572)	(0.22079)
	[0.88822]	[1.08234]	[1.19534]	[1.82859]
D(ZMKFRANC(-1))	-0.003278	-0.026903	-0.015594	0.008457
	(0.02403)	(0.16937)	(0.21089)	(0.02393)
	[-0.13643]	[-0.15884]	[-0.07394]	[0.35341]
D(ZMKRAND(-1))	-0.393918**	-2.56891*	-0.936128	0.073417

	(0.19281)	(1.3589)	(1.69208)	(0.19201)
	[-2.04309]	[1.8904]	[-0.55324]	[0.38237]
C	6.676141	37.35686	70.65687*	7.897035*
	(4.70240)	(33.142)	(41.2687)	(4.68291)
	[1.41973]	[1.1271]	[1.71212]	[1.68635]
R-squared	0.244508	0.233808	0.087491	0.134714
S.E. equation	23.41593	165.0361	205.5003	23.31888
F-statistic	3.560045	3.356716	1.054678	1.712567
Log likelihood	-221.4084	-317.0931	-327.838	-221.2049
Akaike AIC	9.241161	13.14666	13.58522	9.232855
Schwarz SC	9.434204	13.33970	13.77827	9.425897

**Coefficient is significant at 5% & 10%
*Coefficient is significant at 10%

Table3, tabulates the short run results of Vector regressive estimates. The appropriate lag length of one in the VAR was chosen based on the AIC. As can be observed from the VAR output in table 3, the R-squared of all the equations in the system are quiet low implying that the exchange rates in the VAR system are not able to explain each other very well even in the short run. This could be due to lack of cointegration among these variables in the system.
The results in table 3 in model 1 indicate that ZMKUSD and ZMKFRANC do not have significant impact on the ZMKYUAN. However, ZMKRAND has negative significant impact on ZMKYUAN at 5% level of significance. This means that as ZMKRAND begins to appreciate, ZMKYUAN depreciates. This could mean that as trade between Zambia and South Africa increases, the demand for South African Rand increases whereas the demand for Chineses Yuan reduces assuming that trade between China and Zambia reduces or is smaller relative to trade between Zambia and South Africa. Results in model 2 indicate that only ZMKRAND has negative significant impact on the ZMK/USD but only at 10% level of significance. The rest of the exchange rates do not have significant effect on ZMKUSD in model 2. However, the ZMKUSD has also significant effect on ZMKRAND as indicated in model 4. This implies a bidirectional causality between ZMKRAND and ZMKUSD. Interestingly, what one observes in model 2 is that ZMK/YUAN, though not significant, has a negative sign indicating that the ZMKYUAN has negative effect on ZMKUSD. This entails that if there is increase in direct transactions from kwacha to Chinese YUAN or if there is increase in trade between China and Zambia and that there is direct trade from the Zambian kwacha to Chinese Yuan, the ZMKUSD should be able to depreciate. Results in model 3 show that none of the exchange rates have significant short run effect on ZMKFRANC. In model 4, The ZMKYUAN is significant at 10%. The sign for the coefficient of ZMKYUAN is negative, implying that ZMKYUAN has negative significant effect on the ZMKRAND in the short run. These findings show that there is a short run bidirectional causality between ZMKRAND and ZMK/YUAN.

5.2 Policy Implications for Firms, Households and Government and further research

There are two findings that are worth mentioning in a quest to make policy implications and recommendation for the government, firms and households. Firstly, the Johansen test of cointegration showed no evidence of cointegration among exchange rates in the system which as explained earlier implies that there is no long run relationship among exchange rates. Secondly, the Vectorautoregressive systems estimates showed that ZMKUSD and ZMKYUAN do not have short run significant effect on each other. These two findings have serious implications for the government, firms and households. What these findings indicate is that changes in ZMKUSD should not have significant effect both in the short run and in the long run on ZMKYUAN. This means that the fact that ZMK depreciates against the US Dollar kwacha does not mean ZMK depreciates against Chinese Yuan. Since Zambian firms and households find it expensive to import goods using ZMKUSD even when they are importing the goods from China, they can avoid cost of appreciation of US Dollar against the Zambia by trading directly with ZMKYUAN rather than using ZMKUSD and later YUAN/USD. This is because ZMKUSD does not have significant effect on ZMKYUAN both in the short run and long run. The Recommendation therefore, is that the government should work towards enhancing liberalisation of ZMKYUAN in Zambia so that Zambian firms and households should be able to make use of ZMKYUAN when importing goods especially inputs from China as opposed to transforming kwacha into US dollar and then US Dollar to Chinese Yuan. Such direct transactions in ZMKYUAN may lead to reduced demand to some extent on the US dollar and thereby stabilising the kwacha against the US dollar.
Secondly, since results showed that ZMKRAND has short run negative significant effect on ZMKUSD, it means that as ZMKRAND goes up, the ZMKUSD should go down. The Zambian government probably needs to enhance trade policies aimed at increasing trade with South Africa.This may increase use of ZMKRAND in trade and this may have a depressing effect on ZMKUSD. This way, the kwacha may be stabilised against the US Dollar.
Thirdly, the study has research implications for further research. As is observed, this study made use of sample monthly data from December 2007 to February 2012, which is four years and three months period. This was due to data limitations. It would be better that longer series are used. One would argue to say that the findings in the current study are being influenced by shortness of the period of data. It could be that if the series are longer, results may be different. However, the current study is an eye opener for further research.

6. Conclusion

The main objective of the study was to explore possibilities of trading directly with ZMK/YUAN as the Zambian firms and households trade with China. In doing so, the study employed the Multivariate cointegration test and Vector autoregressive (VAR) model for purposes of analysis. The findings showed that exchange rate variables namely ZMKYUAN, ZMKUSD, ZMKRAND and ZMKFRANC do not have long run relationship among each other in the system of equations. This finding implies that changes in ZMKUSD do not have long run effect on ZMKYUAN. This means that it should possible for Zambian firms and households to avoid cost of appreciation of US Dollar by trading directly with ZMKYUAN rather than trading with ZMKUSD and later with YUAN/USD so as to import goods from China. In addition, results in the VAR system showed that ZMKUSD and ZMKYUAN do not have short run significant effect on each other. However, ZMKYUAN has negative effect on ZMKUSD though not significant. This means that increased trade with China and by trading directly with ZMKYUAN, should lead to reduced value of ZMKUSD as the demand for US Dollar would reduce. Therefore, this calls for government to liberalise the transactions in ZMKYUAN. Finally, the findings also showed that the ZMKRAND has significant effect on ZMKUSD in the short run. Thus increased trade with South Africa should be able to contribute to strengthening the ZMK against the USD.

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