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Can Higher Inflation Lead to Currency Appreciation in Nigeria?

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Abstract
This work verified if higher inflation can lead to currency appreciation in Nigeria using an annual data from 1981 to 2013. The ordinary least square (OLS) method was adopted because of its best linear unbiased estimator property. The result showed that current inflation does not lead to currency appreciation in Nigeria, and rather what leads to currency appreciation is expected inflation. Although, monetary policy rate and export were significant in determining Naira value but they did not show the expected signs. The estimated model showed stability and all the explanatory variables used for the analysis accounted for 96% variation in explaining the direction of value of Naira as regards to appreciation or depreciation. The co-integration test showed that a long term relationship existed among the variables and they were stationary at order one I (1).
Keywords: Currency, Inflation, Co-integration and Appreciation

1.0 Introduction

The price one currency in relation to other currencies is regarded as the exchange rate. Exchange rate as a price plays an important key role in driving economic activities in both developed and developing countries. In most countries, monetary authorities try to control exchange rate swings to protect the economy. In Nigeria, one the major objectives of the Central Bank of Nigeria is to ensure stable exchange rate through appropriate exchange rate policy. Nevertheless, since exchange rate is a price, a country's currency can appreciate or depreciate in the foreign exchange market. A currency appreciation is established when there is an increase in the value of one currency against other currencies, while, the opposite is depreciation. There are several factors that could lead to changes in exchange rate, these include, changes in price level, interest rates, bank rate, exports and imports, political conditions and type of an economy. Inflation which is the persistent rise in the general price level is a major factor that can cause change in exchange rate. Economic theory stipulates that an increase in inflation will lead to a currency depreciation and make its goods cheaper in the foreign market (Krugman, 2009).

Clarida (2008) opined that in most developed nations, especially those with inflation targeting policies like Canada; this theory does not hold or be sustained rather; an increase in inflation can lead to currency appreciation. However, in developing nations like Nigeria, there are very few existing study to verify this assertion, therefore, the need to investigate the behavior of this theory in developing nations, thus Nigeria. This study will be of immense benefit to researchers and policy makers in the country to understand the relationship existing between currency appreciation (Naira) and inflation in Nigeria. Consequently, the aim of this study is principally to find out if higher inflation leads to currency appreciation and more so, to investigate if there are other factors that drive currency appreciation in the country. Hence, the leading research question is, does higher inflation lead to currency appreciation in Nigeria? Furthermore, the following questions will help to achieve the real objective of this study.

- What is the relationship between inflation and currency appreciation in Nigeria?
- What is the relationship between expected inflation and currency appreciation in Nigeria?
- What is the relationship between monetary policy rate and currency appreciation in Nigeria
- What is the relationship between money supply and currency appreciation in Nigeria?

To this end, providing answers to these enquiries will assist in structuring a model that will offer responses to above questions and also guide this study.

2.0 Literature Review

2.1 Theoretical Framework

The theoretical framework of exchange rate is based on the traditional theories of exchange rate such as, purchasing power parity theory; assets portfolio approach theory and overshooting theory.

*The purchasing power parity theory emphasizes that exchange rate between currencies of two countries are in equilibrium if their purchasing power are the same in both countries. This means that the exchange rate between two countries should equal the ratio of the two countries price level of a fixed basket of goods and services. Therefore when a countries domestic price level is increasing, that country's exchange rate must be depreciated in order to return to PPP (*The University of British Columbia, www.fx.sauder.ubc.ca/ppp.html)

In addition, the assets portfolio approach hinges on the relative supply and demand of domestic and

foreign bonds including domestic and foreign money. This means that if domestic bonds increase when compared to foreign bonds, it will cause the domestic currency to depreciate, otherwise, it will appreciate. This is based on the assumption that there are no barriers to capital flow between nations.

Additionally, the overshooting theory stresses that exchange rate adjusts faster than prices of goods beyond its long run equilibrium if there is an increase in money supply. Price adjusts slowly and interest rate falls. This leads to an increase in inflation, and in some countries a rise in inflation leads to currency appreciation in the spot market of exchange rate.

2.2 Empirical Literature

Clarida and Waldman (2008) in their work "is bad news about inflation good news for the exchange rate?" took a sample of ten countries – Australia, Britain, Canada, the euro area, Japan, New Zealand, Norway, Sweden, Switzerland, and the United States and examined the exchange rate changes that occurred in the period lasting from five minutes prior to an inflation announce to five minutes afterwards. They found out that on the average for the ten currencies they studied, news that inflation is unexpected high does lead a currency to appreciate and this effect is much stronger for core than headline inflation.

Obi and Gobna (2010) investigated the determinants of exchange rate in Nigeria, by employing co-integration and error correction model. The result showed that improvements in productivity, investment-GDP ratio, and higher inflation lead to exchange rate appreciation. On the other hand, high degree of openness increases in foreign reserves, and interest rate differentials result in exchange rate depreciation.

Oriavwote and Oyovwi (2012) studied the determinants of real exchange rate in Nigeria with data covering 1970 – 2010 by applying the error correction model technique. The result showed that the ratio of government spending to GDP, terms of trade and technological progress are not important determinants of the real effective exchange rate. Nevertheless, capital flow, price level and nominal effective exchange rate are important in determinants of real effective exchange rate in Nigeria.

Ajao and Igbekoyi (2013) examined the determinants of exchange rate volatility in Nigeria from 1981 to 2008. The study revealed that openness of the economy, government expenditures, interest rate movements as well as lagged exchange rate were among the major significant variables as well as lagged exchange rate that determine exchange rate volatility in Nigeria.

3.0 Methodology

Investigating if inflation drives currency appreciation in Nigeria, will show the nature of relationship existing between these two variables. The model to establish such a relationship can be assumed to be linear. The method of ordinary least square (OLS) estimation was used. This technique was preferred because it's best linear unbiased (BLUE) property. The model specification for this study is

$$\ln nvs_t = \beta_0 + \beta_1 \ln \text{inf}_t + \beta_2 \ln \text{inf}_{t-1} + \beta_3 \ln ms2_t + \beta_4 \ln mpr_t + \beta_5 \ln tbs_t + \beta_6 \ln imp_t + \beta_7 \ln \text{exp}_t + \mu_t$$

Where lnnvst = natural logarithm of one unit of Nigeria's Naira against the U.S.A. Dollars
lninf = natural logarithm inflation rate
lninf(-1) = natural logarithm of expected inflation
lnms2 = natural logarithm of broad money supply
lnmpr = natural logarithm of monetary policy rate
lntbs = natural logarithm of treasury bill subscription
lnimp = natural logarithm of import
lnexp = natural logarithm of export
t = current time

β_i = parameters of the explanatory variables.

From the model, the expected signs of these parameters are $\beta_1 < 0, \beta_2 > 0, \beta_3 < 0, \beta_6 < 0$ while, $\beta_4 > 0, \beta_5 > 0 \beta_7 > 0$

The data for this work were collected from the statistical bulletin of the Central Bank of Nigeria. An annual data from 1981 to 2013 of the variables were extracted and used for analysis.

In addition, before estimating the model, unit root tests were performed on the series to evaluate their level of stationarity. The Augumented Dickey-Fuller (ADF) test was used to determine level of stationarity. Its decision rule relies on rejecting a null hypothesis of unit root in favour of alternative hypothesis of a stationarity. Also, to establish if there was a long-run equilibrium relationship among these variables, a cointegration test was carried out. The Johansen cointegration test was adopted which requires all variables to be of the same order of integration. The directions of causality between these variables were investigated using the pairwise Granger Causality test. Causality can be categorized into three; unidirectional causality, bidirectional causality and no causality in a bivariate model.

4.0 Results

4.1 Unit Root Test

The variables were subjected to unit root test using Augmented Dickey-Fuller test for stationarity test

Table 1.0: Stationarity test of the variables

Level test I(0)		**Critical values**		
ADF Stat.	Variables	1%	5%	10%
-1.940729	Lnnvs	-3.653730	-2.957110	-2.617434
-2.802318	Lnmpr	-3.653730	-2.957110	-2.617434
-1.496207	Lntbs	-3.653730	-2.957110	-2.617434
-3.281854	Lninf	-3.953730	-2.957110	-2.617434
-0.638199	Lnimp	-3.661661	-2.960411	-2.619160
-0.769336	Lnexp	-3.653730	-2.957110	-2.617434
-0.188130	Lnms2	-3.653730	-2.957110	-2.617434
Level test l(1)				
-4.797525	Lnnvs	-3.661661	-2.960411	-2.619160
-4.913153	Lnmpr	-3.670170	-2.963972	-2.621007
-6.749851	Lntbs	-3.661661	-2.960411	-2.619106
-6.704712	Lninf	-3.670170	-2.963972	-2.621007
-6.539692	Lnimp	-3.661661	-2.960411	-2.619160
-6.329734	Lnexp	-3.661661	-2.960411	-2.619160
-3.478528	Lnms2	-3.661661	-2.960411	-2.619106

Authour's computation and Eviews 7.1 Output

In table 1.0, the variables at their level form showed unit root. The first differenced series of the variables showed stationarity, which means, that they are integrated of order one I(1).

4.2 Cointegration Test

In order to ascertain if there was a long term relationship existing among these variables, a co-integration test was carried out using the Johansen cointegration test.

Table 2.0 : Trace test

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.867444	176.7506	125.6154	0.0000
At most 1 *	0.758254	114.1075	95.75366	0.0015
At most 2 *	0.625453	70.09154	69.81889	0.0476
At most 3	0.485511	39.64839	47.85613	0.2353
At most 4	0.306052	19.04635	29.79707	0.4896
At most 5	0.162509	7.720237	15.49471	0.4958
At most 6	0.069185	2.222542	3.841466	0.1360

Authour's computation and Eviews 7.1 output

Table 3.0: Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.867444	62.64316	46.23142	0.0004
At most 1 *	0.758254	44.01591	40.07757	0.0171
At most 2	0.625453	30.44315	33.87687	0.1218
At most 3	0.485511	20.60204	27.58434	0.3010
At most 4	0.306052	11.32611	21.13162	0.6148
At most 5	0.162509	5.497695	14.26460	0.6781
At most 6	0.069185	2.222542	3.841466	0.1360

Authour's computation and Eviews 7.1 output

The trace test in table 2.0 showed that the hypothesis of no cointegration among the variables can be rejected and at least three cointegrating equations exist. The maximum eigenvalue test in table 3.0, confirmed the presence long run relationship among the variables of interest with at least two cointegrating equations.

4.3 Granger Causality Test

Table 4.0: Granger Causality test of the variables

Null Hypothesis:	Obs	F-Statistic	Prob.
LNINF does not Granger Cause LNNVS	31	1.87062	0.1742
LNNVS does not Granger Cause LNINF		0.51070	0.6060
LNTBS does not Granger Cause LNNVS	31	0.78369	0.4672
LNNVS does not Granger Cause LNTBS		3.05151	0.0645
LNMPR does not Granger Cause LNNVS	31	0.15262	0.8592
LNNVS does not Granger Cause LNMPR		0.44234	0.6473
LNMS2 does not Granger Cause LNNVS	31	0.01335	0.9867
LNNVS does not Granger Cause LNMS2		5.77830	0.0084
LNIMP does not Granger Cause LNNVS	31	0.12349	0.8843
LNNVS does not Granger Cause LNIMP		6.74798	0.0044
LNEXP does not Granger Cause LNNVS	31	1.75684	0.1925
LNNVS does not Granger Cause LNEXP		5.08783	0.0137
LNTBS does not Granger Cause LNINF	31	1.08610	0.3524
LNINF does not Granger Cause LNTBS		3.97773	0.0311
LNMPR does not Granger Cause LNINF	31	1.30958	0.2872
LNINF does not Granger Cause LNMPR		2.49964	0.1016
LNMS2 does not Granger Cause LNINF	31	4.13273	0.0276
LNINF does not Granger Cause LNMS2		0.17760	0.8383
LNIMP does not Granger Cause LNINF	31	1.85602	0.1764
LNINF does not Granger Cause LNIMP		0.07555	0.9274
LNEXP does not Granger Cause LNINF	31	1.09236	0.3503
LNINF does not Granger Cause LNEXP		1.09158	0.3506
LNMPR does not Granger Cause LNTBS	31	1.12077	0.3413
LNTBS does not Granger Cause LNMPR		2.77608	0.0808
LNMS2 does not Granger Cause LNTBS	31	2.92415	0.0715
LNTBS does not Granger Cause LNMS2		0.41388	0.6654
LNIMP does not Granger Cause LNTBS	31	1.46983	0.2485
LNTBS does not Granger Cause LNIMP		0.61542	0.5481
LNEXP does not Granger Cause LNTBS	31	1.67879	0.2062
LNTBS does not Granger Cause LNEXP		1.32655	0.2828
LNMS2 does not Granger Cause LNMPR	31	2.43333	0.1075
LNMPR does not Granger Cause LNMS2		1.58522	0.2241
LNIMP does not Granger Cause LNMPR	31	1.09446	0.3497
LNMPR does not Granger Cause LNIMP		9.31733	0.0009
LNEXP does not Granger Cause LNMPR	31	0.60106	0.5557
LNMPR does not Granger Cause LNEXP		3.58383	0.0422
LNIMP does not Granger Cause LNMS2	31	1.80181	0.1850

LNMS2 does not Granger Cause LNIMP		0.43993	0.6488
LNEXP does not Granger Cause LNMS2	31	2.91969	0.0718
LNMS2 does not Granger Cause LNEXP		0.36679	0.6965
LNEXP does not Granger Cause LNIMP	31	3.05990	0.0641
LNIMP does not Granger Cause LNEXP		0.02339	0.9769

Authour's computation and Eviews 7.1 output

The Granger causality analysis presented in table 4.0 showed that at 5% significance level that most of the variables do not cause each other under pairwise Granger Causality test. It was equally interesting to find out that none of the variables Granger caused NVS. Nevertheless, there were few cases of unidirectional causality between some variables. These are, NVS and MS2, NVS and IMP, NVS and EXP, INF and TBS, MS2 and INF, MPR and IMP, and, MPR and EXP. There was no case of bidirectional causality at 5% significance level.

4.4 Model Estimation

In estimating the model, ordinary least square method was used to identify the nature of relationship that existed between NVS and other variables using annual data of 1981 to 2003 extracted from the statistical bulletin of Central Bank of Nigeria, December, 2013.

Table 5.0 Model Estimation Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.284414	1.008468	9.206456	0.0000
LNINF	-0.049528	0.112633	-0.439731	0.6641
LNINF(-1)	0.240156	0.111795	2.148175	0.0420
LNMS2	-0.243433	0.208136	-1.169587	0.2537
LNMPR	-1.289344	0.276188	-4.668349	0.0001
LNTBS	-0.038194	0.087253	-0.437740	0.6655
LNIMP	0.118960	0.275471	0.431844	0.6697
LNEXP	-0.572479	0.262387	-2.181809	0.0391

R-squared	0.970954	Mean dependent var	-3.225148
Adjusted R-squared	0.962483	S.D. dependent var	1.851070
S.E. of regression	0.358541	Akaike info criterion	0.998771
Sum squared resid	3.085242	Schwarz criterion	1.365205
Log likelihood	-7.980342	Hannan-Quinn criter.	1.120234
F-statistic	114.6120	Durbin-Watson stat	1.388425
Prob(F-statistic)	0.000000		

Authour's computation and Eviews 7.1 output

$$\ln nvs_t = 9.28 - 0.50 \ln \inf_t + 0.04 \ln \inf_{t-1} - 0.24 \ln ms2_t - 1.29 \ln mpr_t - 0.04 \ln tbs_t + 0.12 \ln imp_t - 0.57 \ln \exp_t$$

The estimated model in table 5.0, the coefficients of main variables of interest inflation and expected inflation showed correct signs but current inflation rate was not significant with probability value of 0.6641. The expected inflation was found to be significant and could be said to be one of the main drivers of currency appreciation in Nigeria with probability value of 0.0420. This result goes to confirm the work of Clarida and Waldman (2008). In their work using data from some developed countries "*we can now understand the "paradox" of higher than expected inflation causing currency appreciation rather than depreciation".* Although, monetary policy rate and export were significant in the model but, they did not show the correct signs. Both had probability value of 0.0001 and 0.0391 respectively. From the result, a 1% increase in expected inflation, Naira will appreciate by 0.24%. The R^2 of 0.9710 which indicates 97% of total variation in the dependent variable can be explained by the explanatory variables. The adjusted R^2 of 0.9625 or 96%, showed that the explanatory variables were robust in explaining the variation in LNNVS.

The Durbin-Watson statistic of 1.3884 indicates a presence of slight autocorrelation in the data. Nonetheless, the F-statistic has a value of 114.61 with probability value of 0.0000, which means, it is statistically significant at 5% and the model is a good fit. Therefore, the explanatory variables have a joint significant effect on the movement

of Naira value in terms of appreciation or depreciation.

4.5 CUSUM and CUSUM SQ Test for Stability

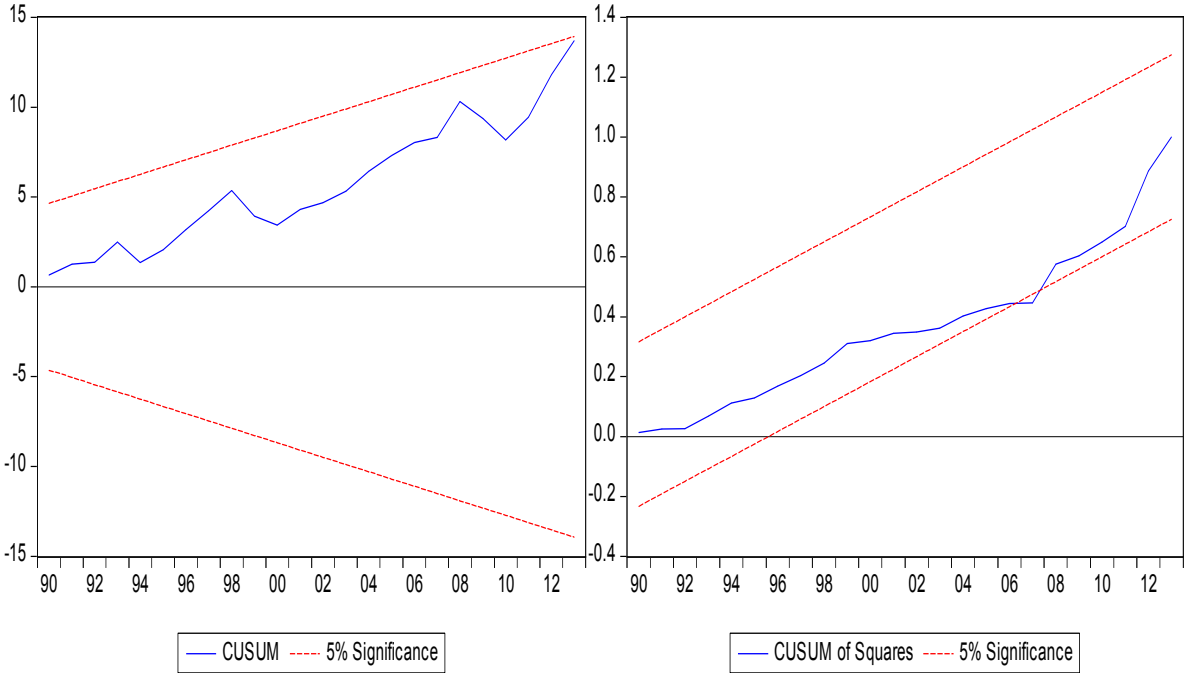
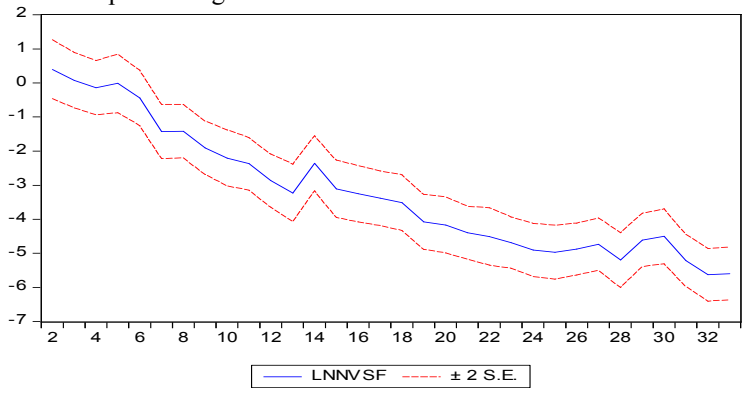


Figure 1.0: Plots of Residuals of CUSUM and CUSUM SQ

The CUSUM and CUSUM SQ are used to evaluate the stability of the model when applied on the residuals. It is expected that both CUSUM and CUSUM SQ plots should be within the critical bounds at 5% significant level for the model to be accepted as being stable. From fig. 1, the CUSUM plot is within the critical bounds meaning that the model is stable, while, the CUSUM SQ plot is slightly out of the critical bounds indicating a minor instability of the model.

4.6 Forecasting Power of the Model

More so, to further evaluate the stability and forecasting power of the model, the Theil's inequality criteria were used. Theil's inequality coefficients are used in studying the accuracy of a forecast. The coefficient of Root-Mean Square Error (RMSE) should be between 0 and 1. The smaller the value, the better is forecast. The bias proportion and variance proportion should have a value of 0 while, the covariance proportion should be equal to 1. From Fig 2.0 below the model satisfied all the conditions of Theils's Inequality criteria for stability and forecasting power. Therefore, it can be used for policy formulation. The plot shows that Nigeria's, Naira will further depreciate against the U.S.A. Dollars.



Forecast: LNNVSF	
Actual: LNNVS	
Forecast sample: 1 33	
Adjusted sample: 2 33	
Included observations: 32	
Root Mean Squared Error	0.310506
Mean Absolute Error	0.243012
Mean Abs. Percent Error	17.13300
Theil Inequality Coefficient	0.041987
Bias Proportion	0.000000
Variance Proportion	0.007369
Covariance Proportion	0.992631

Fig.2.0: Forecasting Plot

5.0 Conclusion

This work tried to investigate if an increase in inflation will lead to currency appreciation in Nigeria. The OLS result showed that expected inflation is the main driver of currency appreciation in Nigeria against the USA Dollars. This is in conformity with research carried out in some advanced countries. In managing the effect of inflation in Nigeria, the Central Bank of Nigeria uses policy interest rate called monetary policy rate. It is expected that as inflation increases, monetary authourities might be forced to increase policy rate to protect the value of Naira, thereby, making Naira, to appreciate against the dollar. Nevertheless, result from the estimated

model showed that monetary policy rate is not an effective tool in driving Naira appreciation in Nigeria. This work will be of great importance to monetary athourities to know that drivers of currency appreciation might not solely be economic factors.

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