E C O N O M I C S   B U L L E T I N

Stability of the Nigerian M2 Money Demand Function in the SAP Period

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Abstract

This paper explores the stability of the M2 money demand function in Nigeria in the Structural Adjustment Program (SAP) period. The results from the Johansen and Juselius cointegration test suggest that real discount rate, economic activity and real M2, are cointegrated. The Hansen (1992), CUSUM and CUSUMQ stability test results indicate that the M2 money demand function in Nigeria is stable for the study period. The results of the study show that M2 is a viable monetary policy tool that could be used to stimulate economic activity in Nigeria.

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1. Introduction

This paper empirically investigates the stability of the M2 money demand function in Nigeria during the Structural Adjustment Program (SAP) period.[1] At issue is whether or not the Nigerian M2 money demand function is stable following the implementation of the SAP in June 1986. The stability of money demand function has important implications for monetary policy in both developed and developing countries. For M2 to be an effective policy target variable, it must share long run relationship with other macroeconomic variables such as real interest rate and economic activity. A number of studies, including Bahamani-Oskooee and Shabsigh (1996), Bahamani-Oskooee and Barry (2000), Bahamani-Oskooee and Bohl (2000), Bahamani-Oskooee (2001), Fielding (1994), Hamori and Hamori (1999), and Hansen and Kim (1995) have examined the stability of money demand function in the context of cointegration analysis.

Bahamani-Oskooee and Shabsigh (1996) examined the stability of both the M1 and M2 money demand functions for Japan. They find M1 money demand function to be stable with and without nominal exchange rate. However, for M2 money demand function, stability was attained only when nominal exchange rate was included as a regressor in the equation. Similarly, Bahamani-Oskooee and Bohl (2000) analyzed the stability of M3 money demand function for German following the monetary unification. Their results indicate that M3 money demand function in Germany is not stable. Bahamani-Oskooee (2001) explores the stability of M2 money demand function in Japan. Bahamani-Oskooee concludes that M2 money demand function is stable in Japan, since M2, real income and interest rate are cointegrated. Bahamani-Oskooee and Barry (2000) examined the stability of the M2 money demand function in Russia. They find evidence of cointegration between the series in the system. While the plot of the cumulative sum of recursive residuals (CUSUM) provided evidence of stability, the plot of the cumulative sum of squares of recursive residuals (CUSUMSQ), on the other hand, revealed that M2 money demand function is not stable. Based on these conflicting results, the authors therefore conclude that the Russian M2 money demand function is unstable. Fielding (1994) examined money demand function in four African countries, including Cameroon, Nigeria, Ivory Coast, and Kenya. Fielding finds evidence in support of cointegration in the case of Nigeria. This result was interpreted as an evidence of long run relationship between M2, real income, and inflation. Hamori and Hamori (1999) analyzed the stability of the money demand function in Germany. The authors suggest that money demand function was stable prior to German re-unification. However, the stability weakened after re-unification.

Ajayi (1977) using the OLS method examined money demand function in Nigeria for the period 1960 through 1970. Ajayi finds that real income and interest rate have significant impact on M2. He therefore concludes that money demand function is stable in Nigeria for the study period. Darrat (1986) explored the demand for money in three major OPEC members including Saudi Arabia, Libya and Nigeria. Applying the Chow, Gupta and Farley and Hinich stability tests he concludes that the money demand function is stable in Saudi Arabia, Libya and Nigeria. Arize and Lott (1986) re-examined the demand for money in Nigeria. They find that both real income and expected inflation are important determinants of money demand in Nigeria. Nwaobi (2002) using data from 1960 through 1995 and the Johansen cointegration framework finds that money supply, real GDP, inflation and interest rate are cointegrated. The author therefore concludes that the Nigerian money demand function is stable.

The preceding studies have provided some insight in relation to the stability of money demand function. However, not much is known about this issue in Nigeria especially during the SAP period. This paper fills this void by examining the stability of the M2 money demand function in Nigeria for the period 1986:2 through 2000:1. Unlike the previous studies on money demand function in Nigeria, the present study applies both cointegration framework and a battery of stability tests. Specifically, in addition to the Johansen and Juselius cointegration test, this study implements the Hansen (1992) and Brown, Durbin and Evans (1975) stability test procedures.

The remainder of the paper proceeds as follows: Section 2 provides the data and summary statistics. Section 3 discusses the methodology of the study. Section 4 presents the empirical results. Section 5 furnishes the summary and the policy implications of the study.

2. Data and Summary Statistics

The data used in this study consist of quarterly observations on real broad money supply (M2) (nominal broad money supply deflated by the consumer price index), economic activity (proxied by real industrial production) and real discount rate for the period 1986:2 through 2000:1. The data were collected from the *International Financial Statistics* (*IFS*), 2001 CD ROM version. Table 1 presents the Summary Statistics, which consist of the mean, median, maximum, minimum, standard deviation, skewness, kurtosis, Jarque-Bera and the associated probabilities. The mean values of real discount rate (DR), real industrial production (IP) and real M2 are -0.83 percent, 1.05 and 7.32 billion naira, respectively. Real discount rate M2 with a standard deviation of 1.23 percent fluctuated the most for the period under consideration. However real M2 recorded the least standard deviation (0.26 billion naira). All of the variables exhibit positive skewness and kurtosis. The Jarque-Bera test statistics and the accompanying probabilities, suggest that DR, IP, and M2 are not normally distributed.

3. Methodology

This study implements the following M2 money demand function for Nigeria:

$$LM2 = \alpha_0 + \alpha_1 LIP + \alpha_2 LDR + \mu \qquad (1)$$

where LM2 represents real broad money supply, LIP is a measure of economic activity (proxied by real industrial production, in our case), LDR stands for real discount rate, while μ is the error term. The regression coefficient on economic activity is expected to be positive (i.e. $\alpha_1 > 0$). In other words, as economic activity improves, demand for money increases. In contrast, the regression coefficient on real interest rate is expected to be negative (i.e. $\alpha_2 < 0$). This stipulation implies that as real interest rate rises, the demand for M2 weakens.

The seasonal unit root tests are undertaken in the context of the Hylleberg *et al.* (1990) framework. We adopt this procedure because many macroeconomic time series tend to show evidence of seasonality. The tests are conducted with and without seasonal dummy variables. The following regression equations are implemented for each of the series:

$$ht = a_0 + \varphi t + \pi_1 h_{1t} + \pi_2 h_{2t} + \pi_3 h_{3t} + \pi_4 h_{4t} + \varepsilon_t \quad (2)$$

$$ht = a_0 + \varphi t + \Omega_1 Si_t + \Omega_2 S_{2t} + \Omega_3 S_{3t} + \pi_1 h_{1t} + \pi_2 h_{2t} + \pi_3 h_{3t} + \pi_4 h_{4t} + \varepsilon_t \quad (3)$$

where t is the time trend, S_{1t}, S_{2t} and S_{3t} are seasonal dummy variables.

$h_t = (1- Z^4)x_t$
$h_{1t} = (1 + Z + Z^2 + Z^3)x_{t-1}$
$h_{2t} = - (1 + Z + Z^2 + Z^3)\ x_{t-1}$
$h_{3t} = - (1 - Z^2)x_{t-2}$
$h_{4t} = - ((1 - Z^2)x_{t-1}$
ε_t = is the error term i.i.d, $(0, \sigma^2)$
Z = lag operator, for instance $Zx_t = x_{t-1}$

Under the HEGY procedure, the null hypotheses are as follows:

(a) H_o: $B_1 = 0$, H_1: $B_1 < 0$
(b) H_o: $B_2 = 0$, H_2: $B_2 < 0$
(c) H_o: $B_3 1 B_4 = 0$, H_o: $B_3 1 B_4 \neq 0$

Hypotheses (a) and (b) are based on the conventional *t*-test while hypothesis (c) involves the *F*-test. The rejection of the hypothesis that $B_1 = 0$ implies that the series exhibits seasonal stationarity. Semiannual unit root in the series is confirmed if the hypothesis that $B_2 = 0$ is not rejected. If the null hypotheses that $B_1 = 0$ and$B_2 = 0$ are rejected, we can conclude that a given time series does not have seasonal unit root and therefore is stationary. A rejection of the null hypothesis that H_o: $B_3 1 B_4 = 0$ implies that the series does not have at least one of the two unit roots in the annual frequency. The order of integration has implications for model specification and therefore must be correctly determined. To this effect, we complement the Hylleberg *et al.* (1990) procedure with the Kwiatkowski *et al.* (1992) (KPSS) unit root test. Under the KPSS unit root method, the null hypothesis is stationarity while the alternative is a unit root. The KPSS unit root test ensures that the null hypothesis of stationarity is rejected only if there is substantial evidence against it.

The Johansen and Juselius (1990) cointegration methodology is used to examine the long run relationship between real discount rate, economic activity and real M2. The Johansen and Juselius cointegration test yields two likelihood ratio test statistics, including the trace test and the maximum eigenvalue test. However, this study calculates and reports only the results for the trace test. Cheung and Lai (1993) have shown that the trace test is more robust in detecting the existence of cointegration than the maximum eigenvalue test. Under the trace test, the null hypothesis that there are at most r cointegrating vectors is tested against the alternative.

3.1. Structural Stability Tests

The Johansen and Juselius cointegration test is not informative relative to the stability of the parameters in the system. To this end, we employ the Hansen (1992) parameter stability tests in cointegrated relationships. The Hansen (1992) procedure yields three test statistics, including the SupF, meanF and L_c. These tests are based on the recovered residuals from the estimation of fully modified OLS (FM-OLS) regressions. The null hypothesis under SupF is cointegration while the alternative is no cointegration. However for MeanF and L_c, the null hypothesis is cointegration while the alternative is a random walk.[2] In addition to the Hansen (1992) stability tests, we also utilize the CUSUM and CUSUMSQ procedures (Brown, Durbin and Evans, 1975) to check for structural change in the M2 money demand function. The CUSUM test is based on the cumulative recursive sum of recursive residuals. The CUSUMSQ test, on the hand, is based on the cumulative sum of squares of recursive residuals. Both the CUSUM and the CUSUMSQ procedures are updated recursively and are plotted against the break points. Parameter stability is indicated when the plots of the CUSUM and the CUSUMSQ stay within the 5 percent significance level. However, the parameters and hence the variance are unstable if the plots of the CUSUM and the CUSUMSQ move outside the 5 percent critical lines.

4. Empirical Results

The first step of our empirical analysis is to test for seasonal unit roots using Hylleberg *et al.* (1990) procedure, since our study involves quarterly data. Table 2 presents the HEGY unit root test results. The results indicate that real discount rate, economic activity and real M2 do not display seasonal non-stationarity. They, nevertheless, have unit roots at the zero frequency; since the null hypothesis that $B_1 = 0$ could not be rejected at the 5 percent level of significance. To attain stationarity, the series must be differenced. The KPSS unit root procedure is used to check the robustness of the HEGY results. The KPSS unit root tests are reported in Table 3. The results suggest that all of the variables have unit roots at the level. They are however stationary at the 5 percent level of significance, after first differencing. In a nutshell, the KPSS unit root test results indicate one order of integration [I(1)] for all of the series. These results are consistent with those obtained from the HEGY procedure.

Having determined the order of integration for each of the time series, we next employ the Johansen and Juselius cointegration procedure to examine the existence of long run relationship between real discount rate, economic activity and real M2. The results indicate that there is one cointegrating vector in the system. The trace statistic rejects the null hypothesis of no cointegration at the 5 percent significance level. However, the null hypotheses of at most 1 and 2 cointegrating vectors could not be rejected, since the test statistics are less than the critical values. The existence of cointegration suggests that there is stable relationship between real discount rate, economic activity and real M2. Panel B of Table 4 reports the estimated parameters of the Johansen and Juselius cointegration test. The cointegrating vector was normalized on real M2 by setting its coefficient to –1. Consistent with economic theory, real discount rate has a negative and significant influence on real M2. As expected, economic activity has a positive and statistically significant effect on real M2.

The final step in our investigation involves checking for structural change in the money demand function. The results for the Hansen (1992) SupF, MeanF and L_c tests are presented in Table 5. The results suggest that the relationship between real discount rate, economic activity and real M2 is stable, since the test statistics are not statistically significant at the 20 percent level. To check the robustness of the Hansen (1992) test results, we also implemented the Hansen (1991) parameter instability test. This procedure yields a joint test statistic of 1.23. The critical value at the 5 percent level is 1.68. Since the test statistic (1.23) is less than the critical value (1.68), we therefore surmise that the parameters and the model are stable for the period under consideration.[3] This result corroborates those obtained under the Hansen (1992) framework. Figures 1A and 1B reveal the plots of the CUSUM and the CUSUMSQ, respectively. As can be seen from the Figures, plots of both the CUSUM and the CUSUMSQ stay with the 5 percent critical bounds, indicating the stability of the parameters and thus the overall model. Taken together, the results of the study suggest that the Nigerian M2 money demand function is structurally stable in the SAP period.

5. Summary and Policy Implications

This paper has examined the stability of M2 money demand function in Nigeria during the SAP period (1986:2 to 2000:1). The HEGY and KPSS frameworks were used to determine the order of integration for real discount rate, economic activity and real M2. The Johansen cointegration test was used to ascertain the existence of long run equilibrium relationship among the time series. To check for structural stability, we employ the Hansen (1992) stability test, the CUSUM and the CUSUMSQ procedures.

The results from both the HEGY and KPSS unit root tests suggest that the time series have one order of integration [i.e. I(1)]. The Johansen and Juselius cointegration test indicates that there is a long run relationship between real discount rate, economic activity and real M2. The existence of cointegration among the series suggests that the M2 money demand function in Nigeria is stable. The results from the Hansen stability tests, the CUSUM and the CUSUMSQ frameworks suggest that the Nigerian M2 money demand function is stable in the SAP period. The results of this study implicate M2 as a viable monetary policy tool in Nigeria. Hence the Nigerian monetary authorities can stimulate economic activity by manipulating broad money supply.

ENDNOTES

1. The SAP was implemented to correct the imbalances that the Nigerian economy witnessed following the drop in oil revenue.
2. Hansen (1992) provides the details on the calculation of the various tests.
3. The critical value was taken from Hansen (1991).

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Table 1 Summary Statistics

	LDR	LIP	LM2
Mean	-0.83	1.05	7.32
Median	-0.39	1.21	7.34
Maximum	0.98	2.74	7.78
Minimum	-2.47	-0.49	6.87
Std.Dev	1.23	1.16	0.26
Skewness	-0.09	-0.05	-0.07
Kurtosis	1.36	1.38	1.87
Jarque-Bera	6.39	6.13	8.01
Probability	0.04	0.05	0.02

LDR = real discount rate, LIP = real industrial production (billions of Nigerian naira), LM2 = real broad money supply (billions of Nigerian Naira)

Table 2 HEGY Test for Seasonal Integration

Series	Model	H_o:$B_1 = 0$	H_o:$B_2 = 0$	F:$B_3 \cap B_4 = 0$
LDR	I, SD	-0.70	-3.70	31.56
	I, T, SD	-1.99	-3.77	33.14
LIP	I, SD	-0.77	-5.01	19.96
	I, T, SD	-1.52	-5.05	19.95
LM2	I, SD	-1.89	-4.39	23.38
	I, T, SD	-1.47	-4.35	22.79

LM2 = real broad money supply,, LDR= real discount rate, LIP = real industrial production, I = intercept, T= time trend, SD = seasonal dummies. The critical values were obtained from HEGY (1990) for 100 observations. The critical values at the 5% significance level are as follows:

	B_1	B_2	$B_3 \cap B_4$
I, SD	-2.95	-2.94	6.57
I, T, SD	-3.53	-2.94	6.60

Table 3 KPSS Unit Root Tests

Series	Level	Difference	Lags
LDR	$\eta_u = 0.998$	$\eta_u = 0.134^{**}$	2
	$\eta_t = 0.151$	$\eta_t = 0.131^{**}$	2
LIP	$\eta_u = 1.030$	$\eta_u = 0.145^{**}$	2
	$\eta_t = 0.164$	$\eta_t = 0.141^{**}$	2
LM2	$\eta_u = 0.567$	$\eta_u = 0.243^{**}$	1
	$\eta_t = 0.150$	$\eta_t = 0.089^{**}$	1

** 5 percent significance level. η_u = without trend. η_t = with trend. The critical values for KPSS at the 5% significance level are 0.463 and 0.146, for without trend and with trend, respectively.

Table 4 Multivariate Cointegration Tests

	Null Hypothesis	Likelihood Ratio	5% Critical Value	Eigenvalue
Panel A: Trace Test				
	r =0	41.96**	34.91	0.346160
	r ≥1	18.17	19.96	0.222044
	r ≥2	4.11	9.24	0.070767

Panel B: Estimate of Johansen Cointegrating Vector

LM2	LDR	LIP	CONSTANT
-1.00	-5.44[a]	5.70[a]	-19.22[a]
	(7.92)	(8.56)	(17.74)

** indicates rejection of the null hypothesis at the 5% level of statistical significance.
[a] indicates significance at the 5% level. The numbers in parenthesis represent the LR statistics. The 5% critical value of x^2 (1 degree of freedom) is 3.841.

Table 5 Tests for Parameter Stability

Test	Statistic	*P*-value
SupF	4.34	>0.20
MeanF	2.90	>0.20
L_c	0.16	>0.20

The *p*-values were obtained from the GAUSS program..

Figure 1A: Cumulative Sum of Recursive Residuals

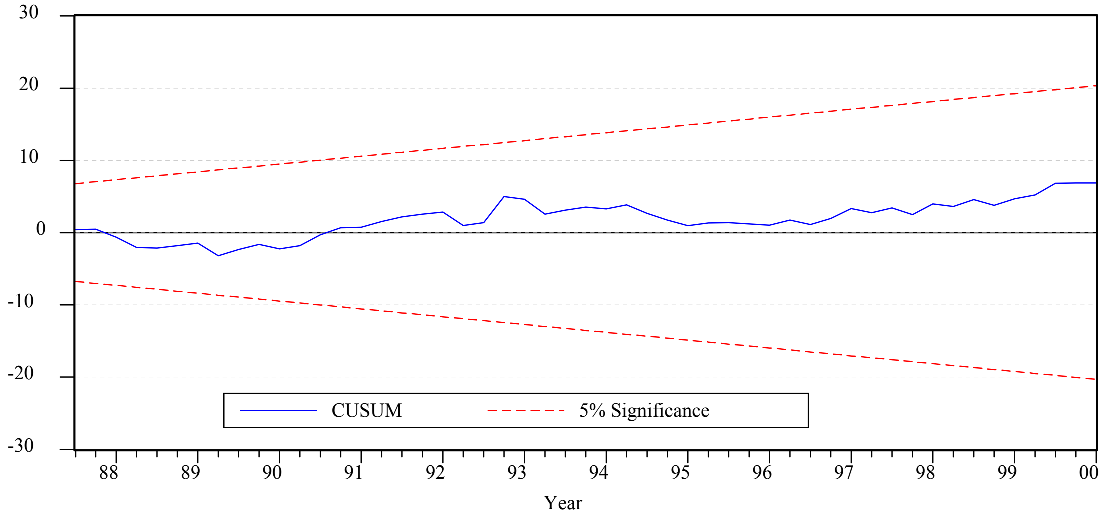

Figure 1B: Cumulative Sum of Squares of Recursive Residuals