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Is Money Supply Stationary in Ghana?

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Abstract:
The paper investigate the unit root properties of Ghana's money supply (M2) using Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root models for the period of 1970-2011 in a linear model using annual data. The empirical results suggest significant unit root in M2 series of Ghana during the period under discussion. Shocks to M2 series are permanent and not temporary. Monetary policy makers should incorporate these findings into their policy plans. In using M2 series for econometric time series analysis the findings should be taken into consideration to avoid spurious results. Future studies should examine unit root with structural breaks and panel unit root model.

Key words: *Finance; unit root; business cycle M2; permanent shock*
Jel Classification codes: C22; E32

1. Introduction

The seminal work of Nelson and Plosser (1982) on the stationary properties of some U.S. macroeconomic series variables has motivated lots of empirical research in finance and economics, on the stationary state of financial and macroeconomic series in recent years with inconsistent results (Shelley & Wallace, 2010; Perron & Phillips, 1987). The finding of Nelson and Plosser (1982) was not in support of that of the hypothesis of business cycles (Campbell & Mankiw, 1987) which is of the view that real GDP is stationary and as such shocks to output fluctuations in an economy is temporary. As a result of the inconsistencies in the literature, various models such as linear; nonlinear, single data and panel data are used in examining the unit root processes of the series (Furuoka, 2011; Beechey & Osterholm, 2008; Chen, 2008; Hurlin, 2004; Kapetanios et al., 2003; Cancer & Hansen, 2001; Shin & Lee, 2001).

The thesis is that if series variables are stationary, then any shock to such series becomes temporary and if the series are not stationary, any shock to such series remain permanent (Smyth & Inder, 2004; Li, 2000). Understanding of the unit root process of series variables has efficiency implications in areas such as econometric estimations, policies and forecasting (Libanio, 2005). Among the series variables that have attracted the attention of research is money supply. The results of the unit root processes of money, such are found in the works of various researchers (Chiaraah & Nkegbe, 2014; Ahmad & Mahmood, 2013; Badarudin, 2012; Ly, 2012; Miyao, 2004; Fong & Li, 2003; Christos & Erotokritos, 2002; Caporale, 1999; Soejima, 1996)

Chiaraah and Nkegbe (2014) used dickey-fuller (DF) and ADF to examine unit root properties of money supply in Ghana using various models such as a model with intercept, trend and intercept and a model without none. The results in level (tob.= -1.977: tcri.= -3.724) with a model with intercept indicates unit root at 1% level of significance. The series achieved stationary state after first difference at 5% level of significance (tob.= -4.083: tcri.= -2.986). The model with trend and intercept did not produce different results (tob.= -0.614: tcri.= -4.394) at 1% and 5% (-3.612). The series achieved stationary state after first difference. In a model without constant and trend and intercept the series achieved stationary state after second differencing.

Badarudin et al. (2012) examine the unit root properties of Australian money supply for the period between 1977.1-2007.1. The results are shown in Table 1. The results indicate that the variable are integrated of order 1 (I(1)) for both sample periods. The PP unit root tests results indicate that the null hypothesis of a unit root could not be rejected at levels. This indicates that they are non-stationary at levels. The null hypothesis is rejected at the 1% significance level when the series variables were differed once. The results support the unit root assumption.

	1977Q1-2007Q1		1977Q1-1993Q2		1993Q3-2007Q1	
	Level	Diff.	level	Diff.	level	Diff.
LM3	-1.26	-1.707	-2.15	-4.34	-0.62	-7.33

Table 1: Unit root test: Phillips-Perron
*NB: * denotes significance at the 1% level, C and T indicates that the unit root test includes a significant constant and trend term respectively.*

Liang and Huang (2011) examined unit root properties of U.S. money supply series and reported of results (tob= 0.025055; tcri.= -3.600) that support unit root assumption in the series using ADF model in level and with log at 1% level of significance. The results did not change at 5% and 10% levels of significance. The series variables attained stationary state after first difference (tob.= -6.38222; tcri. = -3.60099).
Ziotis and Papadas (2011) examined unit root properties of Greece money supply. Table 2 report the unit root testing results for the levels of the series variables and the corresponding results when the series are first differenced. The series are unit root in levels but become stationary when first differenced. There is unit root in Greece money supply.

Variables in level	Lags	ADF test
LM1 (money supply)	12	2.921985
Variables in first difference		
LM1	11	-6.346122

Table 2: Unit Root Test
NB: -5% critical=-2.87: 1% critical =-3.45

Miyao (2004) reported of result that support unit root null assumption in Japan's money supply in levels for the period 1975-2003. The series attained stationary state after first difference. Li and Fong (2003) study accepted the null hypothesis of unit root in U. S. money supply. Christos and Erotokritos (2002) used ADF and PP models to examine unit root processes of real money supply and could not clearly established whether there is unit root or not in Greek real money supply series. Al-Bazai (1999) established unit root properties in Saudi Arabia money supply based on ADF and PP models for the period 1971.1 to 1995.4. The money supply series are integrated of order one (I(1)). The results based on ADF model and PP are shown in Table 3. The series attained stationary state after first difference.

Variable	ADF		PP	
	N[a]	C&T[b]	N[a]	C&T[b]
Lm	0.59 (-1.67)	-2.01 (-3.42)	1.92 (-9.16)	-1.06 (-11.13)

Table 3: Unit root tests

- Numbers in parentheses are for the tests in first differences.
- a: 5% critical value is -1.94, 10% critical value is -1.61.
- b: 5% critical value is -3.41
- Critical values are taken from Mackinnon (1991.)
- N: model without constant and time trend.
- C & T: model with constant and time trend

Robertson and Orden (1990) reported of unit root in New Zealand money supply for the period of 1964.1-1987.1 using ADF in a model with constant and linear trend at 10% level of significance. The results indicate that money supply in New Zealand is not stationary and as such shock to money supply will not be temporary. The review results show that there is no consistent empirical agreement on the stationary properties of money supply which calls for further empirical work with current data.

1.1. Statement of problem/Motivation/Significance
In all economies money supply is theoretically and empirically believed to influence variables such as prices indices of goods and services. The use of monetary policies to achieve economic stability works among other things through money supply. In order to examine the effect of money supply on the various macroeconomic variables there is the need to examine the unit root properties of money supply to avoid spurious results.
The focus of the current paper is to empirically examine the stationary properties of money supply in order to determine if the effect of shock to Ghana's money supply is temporary or permanent. In the knowledge of the researcher very empirical works exist in the literature on the on small but open developing economies such as Ghana in a detail study. The paper fills in the literature gap. The empirical verification of the unit root properties of money supply have resulted in inconsistent results.
The findings of the research contribute to the theories of unit root by providing answers to the research questions raised in the paper. The empirical results provide information to policy makers on the nature of unit root properties and its policy implications for government monetary policies. Students doing research using money supply as dependent or explanatory variables are also provided with useful reference material.

1.2. General objective and specific objectives

The paper contributes to the body of knowledge the in literature in the area of stationary state properties of macroeconomic series variables by empirical examining the nature of unit root processes of Money supply (M2). The paper specifically

- Investigate the unit root properties of M2 series variable.

1.3. Research questions

The question underlying the research is;

- What is the nature of the effect of shock on M2? This question is asked to determine if a shock to M2 will be permanent of temporary.

1.4. Hypothesis Tested

The assumption behind the research is;

- H1: The unit root hypothesis is valid for Ghana in the case of M2 series during the period under discussion. Shock to M2 is not temporary as proposed by business cycle theorists.

1.5. Limitations/Scope

M2 data used in the current study are secondary data from World Bank data base. The series variables might suffer from missing values; errors in variables which might not be known by the researchers.

The rest of the paper looks at research methodology, empirical results; conclusions and recommendations.

2. Research Methodology

The paper is based on quantitative research design, descriptive research format. The study is based on annual M2 data for Ghana for the period 1970-2011. The period was chosen for availability of data. The sample size is 41. Articles reviewed for the paper was selected through purposive sample method. The data used in the estimation is M2 series variables.

2.1. Data Analysis Method

The analysis of the data for the current study is based on KPSS and ADF models.

2.2. The ADF Model

The unit root test is performed using the Augmented Dickey-Fuller (1981). The ADF test is considered to have low power of tests as compared to the KPSS test (Nanthakumar and Subramaniam, 2010) and it is considered to be able to accept a false null hypothesis of a unit root. The null assumption (H_o) is that there is a unit root in the levels of the series. The alternative hypothesis (H_1) is that the series is stationary in levels. Adopting Nanthakumar and Subramaniam (2010) approach, the ADF model is specified as;

$$\Delta M2_t = \alpha_t + \beta_t\gamma_t + \rho M2_{t-1} + \sum_{i=1}^{q} \partial \Delta M2_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

Where γ = trend coefficient, M2= time series variable in the model (Proxies for money supply), ε_t = error term or stochastic error term.

Hurng et al. (2007) modelled the ADF model in three forms as shown in equation (2), (3), (4).

$$\Delta M2_t = \sum_{i=1}^{p} \gamma_i \Delta M2_{t-1} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$\Delta M2_t = \mu + \beta G_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta M2_{t-i} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

$$\Delta M2_t = \mu + \partial T + \beta G_{t-1} + \sum_{i=1}^{p} \gamma_i \Delta M2_{t-i} + \varepsilon_t \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (4)$$

Where $M2_t$ = level of the series variable, μ= drift term, T = time trend, P = number of lags, Δ= shows the series are in their first difference. The ε_t is the error term/ white noise which have the features of normal distribution. It's expected mean value is zero

and has constant variance. The errors are independent of each other. Equation (2) has no constant term and time trend while equation (3) has a constant term with equation (4) having constant term, and time trend.
The KPSS (1992) model is based on the null assumption of stationary state against the alternative hypothesis of unit root. It is used as a confirmatory test after the ADF test has been used. It is modeled based on the residuals (e_t) from an ordinary least square regression of the series variable of interest on the exogenous variable (s). The model is specified as in equation (5) and (6).

$$N_t = N_t\beta + \varepsilon_t \quad \ldots\ldots(5)$$

Where N_t = the series variable under investigation (gross fixed capital formation and credit to the private sector); M_t = a vector of exogenous variable(s). The Lagrange Multiplier is based on equation 4.

$$LN = T^{-2} + \sum_{i=1}^{T} S(t)^2 / f_o \quad \ldots\ldots(6)$$

Where T= the sample size; S (t) = the partial sum of residuals, given by: S(t) = $\sum_{i=1}^{t} S_r$;

ε_t = the estimated residual; f_o = an estimator of the residual spectrum at zero frequency.

3. Empirical Results
The empirical results on descriptive statistic; ADF test results and KPSS are presented and discussed in this section of the paper. The results are reported in Tables.

3.1. Summary of Descriptive statistics
The results of the summary statistics of the variables are shown in Table 4. The minimum and maximum values measure the degree of variations in the variables under investigated. M2 varies between 11.3050 Ghana Cedis and 34.1082 Ghana Cedis. The mean measures the central tendency of the series variables and the values indicate a good fit. The volatility of the series variables are measured by the coefficient of variation.
The nature of the distribution of the series is measured using the coefficient of skewness. M2 is positively skewed. The nature of the peaks of the series variables was measured using the coefficient of kurtosis (Pearson, 1905). The coefficient values of the kurtosis of the M2 series variables (-0.971887) is less than zero (0) which indicates more flat-topped distribution.

Variable	**Mean**	**Median**	**Minimum**	**Maximum**
Money supply (M2)	22.4463	22.5885	11.3050	34.1082
Variable	**Std. Dev.**	**C.V**	**skewness**	**Ex. Kurtosis**
Money supply (M2)	6.23912	0.277958	0.0329959	-0.971887

Table 4: Summary Statistics, using the observations 1970 - 2011
Sources: Author's computation, 2013

3.2. The ADF Test
The ADF test for unit root is based on the null hypothesis that the series variables under investigation are unit root (series are non-stationary) against the alternative hypothesis that the series are not unit root (series are stationary). The results of the ADF test for unit root in levels show that the M2 series are non-stationary. Table 5 reports the results. The null hypothesis of unit root was accepted for M2 series variables.

Variables (Levels)	**t-statistics**	**ADF P-Value**	**1% Critical Value**	**5% Critical Value**	**10% Critical Value**	**Results**	**Lag length**
M2	-1.195	0.6756	-3.641	-2.955	-2.611	Accept Ho (Unit root)	0

Table 5: ADF stationary state test results with a constant
Source: Author's computation, 2013

Taking the logarithm of the first difference of the series and testing these with intercept and trend did not make M2 series stationary. The results are reported in Table 6. These results indicate that the series exhibit unit root processes.

Variables (First Difference)	t-statistics	ADF P-Value	1% Critical Value	5% Critical Value	10% Critical Value	Results	Lag length
ΔlnM2	-2.756	0.2137	-4.270	-3.552	-3.211	Accept Ho (Unit root)	2

Table 6: ADF stationary state test results with a constant and a time trend
Source: Author's computation, 2013

3.3. The KPSS Test

The KPSS test is based on the null assumption (Ho) that the series variables under investigation are stationary (series are not unit root) against the alternative hypothesis (H1) that the series are not stationary (series are unit root). The KPSS is a reversed test for unit root. It is used in the current paper in addition to the ADF for confirmation of the stationary state properties of the series. The results are reported in Table 7. The series were examined in levels and in first difference as were as in their logarithm form. The results are mixed. M2 series are not unit root in levels but become nonstationary in first difference indicating that the series are not integrated of order one, I (1). The null hypothesis of stationary state is rejected at 10% level of significance.

Variable	KPSS P-value	Results	Lag length
M2-level	0.192296	Accept Ho	3
ΔlnM2-1st difference	0.0759265	Reject Ho	3

Table 7: KPSS stationary state test results with a constant and a time trend
Source: Author's computation, 2013

4. Conclusion and Policy Implications

The detection of unit roots in the series indicate that shocks to the M2 series will have permanent effects and not transitory effects. M2 series in Ghana for the period under discussion do not follow business cycle hypothesis of mean-reverting. The results lend support to the view of Nelson and Plosser (1982 that macroeconomic variables are unit root.

The findings are consistent with that of previous researcher such as Chiaraah and Nkegbe (2014); Badarudin and Khalid (2012); Liang and Huang (2011); Ziotis and Papada (2011) Who established unit root processes in M2 series variables and concluded that M2 series are not stationary. The findings are contrary to that of Christos and Erotokritos (2002) examined unit root processes of real money supply and could not clearly established whether there is unit root or not in Greek real money supply series.

The results also indicate that any regression analysis using the series without taking into account the stationary state properties of the series will be spurious. Economist and finance researcher should consider the unit root properties when dealing with time series M2 values to avoid spurious regression results. Monetary policy maker should incorporate these findings into their policy plans to be able to meet their forecasted targets. Theories on business cycle in relation to M2 series must be revised. Future studies should consider the issue of unit root with structural breaks and also use current unit root models such as panel unit root.

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