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The Dynamic Causality between Money and Macroeconomic Activity: Empirical Evidence from Nigeria (1960-2011)

(Penyebab Dinamik antara Wang dengan Aktiviti Makroekonomi: Bukti Empirikal dari Nigeria (1960-2011))

Tajudeen Mukhtar Olatunji
(School of Economics, Faculty of Economics and Management
Universiti Kebangsaan Malaysia)
Adedokun Adebayo Sunday
Yaqub Jameelah Omolara
(Department of Economics, Faculty of Social Science
University of Lagos)

ABSTRACT

This paper examines the dynamic causality between money and macroeconomic activities (output, interest rate, exchange rate and prices) in Nigeria between 1960 and 2011. The methodologies applied include the multivariate cointegration test developed by Johansen (1988) and Johansen and Juselius (1990), the Granger causality test in vector error correction model (VECM), impulse response function (IRF) and variance decomposition (VDC) method. The cointegration test indicates that a long run relationship exists among the macroeconomic variables. The VECM results show that, in the short-run, real GDP and money supply stand out econometrically exogenous, whereas the presence of causal relationships among the variables shows that money supply is not neutral in the short-run. There are unidirectional short-run relationships running from (1) broad money to price, (2) money supply to interest rate and (3) narrow money to exchange rate. The IRF indicates that a positive money shock would increase output and prices, while decreasing interest rates. The exchange rate, however, will remain relatively unchanged and stable for the first two years before decreasing. Considering the definitions of money stocks, broad money (M2) appears to have a stronger causal effect on real output than narrow money (M1). The VDCs show that money supply contains better information about the source of shocks that is affecting the economy when compared to others variables. This implies that money supply could be very useful for predicting the current and future growth rate in output and prices in the Nigerian economy. The Granger causal chain implies that the findings are consistent with the quantity theory of money as opposed to other economic paradigms. However, it also suggests that monetary policy alone is insufficient to achieve sustainable economic growth and price stability.

ABSTRAK

Kajian ini menguji hubungan penyebab dinamik antara wang dengan aktiviti ekonomi (output, kadar faedah, kadar tukaran dan harga) di Nigeria antara tahun 1960 hingga 2011. Metodologi yang digunakan termasuk ujian kointegrasi multivariat yang dikemukakan oleh Johansen (1988) dan Johansen dan Juselius (1990), ujian penyebab Granger dalam model pembetulan ralat vektor (VECM), fungsi tindak balas teritlak (IRF) dan kaedah penguraian varians (VDC). Ujian kointegrasi menunjukkan wujud hubungan jangka panjang antara pemboleh ubah makroekonomi. Dapatan dari VECM menunjukkan yang dalam jangka pendek, KDNK sebenar dan penawaran wang secara ekonometrik jelas bersifat exogenous. Sementara itu, kewujudan hubungan penyebab antara pemboleh ubah menunjukkan penawaran wang tidak bersifat neutral dalam jangka pendek. Didapati wujud hubungan jangka pendek satu hala yang datangnya dari (1) wang luas kepada harga, (2) penawaran wang kepada kadar faedah dan (3) wang sempit kepada kadar tukaran. Hasil IRF pula menunjukkan bahawa kejutan positif dalam wang akan meningkatkan output dan harga, tetapi menurunkan kadar faedah. Kadar tukaran bagaimana pun secara relatif tidak berubah dan stabil untuk dua tahun pertama sebelum ia mula menurun. Dengan mengambil kira definisi stok wang, kesan penyebab wang luas (M2) ke atas output sebenar didapati lebih kuat berbanding wang sempit (M1). Hasil analisis VDC menunjukkan yang penawaran wang mempunyai maklumat mengenai sumber kejutan yang mempengaruhi ekonomi yang lebih baik berbanding pemboleh ubah lain. Ini menunjukkan penawaran wang boleh digunakan untuk meramalkan kadar pertumbuhan semasa dan masa depan bagi output dan harga dalam ekonomi Nigeria. Rantaian penyebab Granger menunjukkan penemuan kajian ini adalah selari dengan teori kuantiti wang, berbanding paradigm ekonomi yang lain. Bagaimanapun, penemuan tersebut juga menyarankan bahawa polisi monetari secara solo tidak memadai untuk mencapai kelestarian dalam pertumbuhan ekonomi dan kestabilan harga.

Keywords: Macroeconomic Activities; Quantity Theory of Money; Monetary Policy; Cointegration; Granger Causality; Vector Error Correction Model (VECM).

INTRODUCTION

One of the principal concerns among economists, scholars and policy makers is the causal relationships between money and other macroeconomic aggregates, such as income, price, interest rates, and exchange rates. These causal relationships are crucial because they reveal the appropriateness and effectiveness of a particular monetary policy, especially in a small open economy, such as Nigeria that has a history of double digit inflation and epileptic output performance. Different schools of thought in economics have postulated various relationships between money and macroeconomic aggregates. The Keynesians, monetarists, new classical and new Keynesians agree that monetary shocks have a positive effect on output. These groups, however, disagree on the nature and transmission channels of these positive effects. While the Keynesians postulate that a positive monetary shock would increase both economic activity and price level through interest rates and investment, the monetarists disagree with a long run positive effect of monetary shocks in line with classical reasoning. The new classical economists decompose the effect of monetary shocks on the basis of anticipated monetary expansion, opining that only unanticipated monetary expansion will lead to an increase in the output.

The new Keynesians postulate the non-neutrality of money, at least in the short run, because of the rigidities in prices and wages; market failure; and imperfection (Erjavec et al. 2003). As indicated in real business cycles, a monetary shock has no positive effect on output, but raises interest rates and price level. According to this theory, money supply is endogenous, while output is determined exogenously, primarily by technology. In the meantime, the existing macroeconomic paradigm implies that the dynamic causal relationships between money and macroeconomic aggregates (such as output and price level) are ambiguous and unresolved. In view of these theoretical arguments, it is essential to re-examine the issue of causality among money, income, interest rates, exchange rates and price levels, as well as the short run and long run relationships between these variables. Nigeria provides an appropriate setting for a study with this objective.

During the period under consideration in this study, four episodes of high inflation, exceeding 30%, have been recorded. The first occurred in 1975; the second and third occurred in 1984 and between 1987 and 1989 respectively; and the fourth episode occurred between 1993 and 1995. The first high inflationary trend is attributed to the excessive monetarization of oil revenue. The second episode is linked to supply-side factors, such as oil price shocks, while the third and the fourth episodes are attributed to fiscal and monetary expansions. In Nigeria, the trend in monetary policy between 1971 and 1986 was characterized, to a certain extent, by the adoption of the fixed exchange rate policy. This was followed by a dual exchange rate system where a fixed exchange rate (for official transactions) and a market determined exchange rate (for other items) co-existed. The two systems were later unified into a single foreign exchange market. The foreign exchange market was eventually deregulated in 1992 for a complete floating of the Naira (the Nigerian domestic currency). However, there was a reversal from the complete float in 1994 following the continuous depreciation of the Naira. Since 1999, the naira has been allowed to float again, albeit with occasional intervention from the central bank of Nigeria to smooth the volatility of exchange rates.

The purpose of this paper, therefore, is to test the dynamic casual relationships between money and other macroeconomic aggregates, specifically output, price level, interest rates and exchange rates for the small open economy of Nigeria. Exchange rates are incorporated in the analysis because of the dynamic interactions of these variables with the foreign trade sector. The rest of the paper is organized as follows. The next section presents the literature review. The section after that discusses the research methodology. The following section presents the empirical results of the vector error correction model (VECM), impulse response functions (IRFs) and variance decompositions (VDCs) and, finally, the last section concludes and provides economic implications of the results.

LITERATURE REVIEW

Issues concerning money supply and macroeconomic aggregates are well documented in literature across several strands of opinions. Erjavec and Boris (2003) investigate the causal relationships between money and other macroeconomic variables, such as output, interest rates, prices and exchange rates, using time series data from the Croatian economy. They employ a methodology that involves Granger-causality analysis in a vector auto regression model with an application of variance decompositions and impulse response functions to establish the direction of causality between money and other macroeconomic variables. The result shows that short-run variables, interest rates and nominal exchange rates stand out as econometrically exogenous. During their study period from 1994: 10 to 2001: 10, these variables serve as the initial receptors of exogenous shocks to the long run equilibrium. The causal relationships that are detected among the variables suggest that money supply is neutral, at least in the short run.

Ahmed and Suliman (2011) investigate the long-run relationships between three macroeconomic variables (real Gross Domestic Product (GDP)), money supply and price level (CPI), for the Sudanese economy using annual time series data spanning from 1960 to 2005. They employ Granger causality techniques and co-integration tests to establish the long run relationship between the three variables. The results first demonstrate that the direction of causation between real GDP and prices is unidirectional running from real GDP to CPI. Second, a unidirectional

causation also runs from money supply to CPI. Lastly, there is no causality between real GDP and money supply variable. However, real GDP, money supply and CPI are co-integrated, suggesting that a long run relationship exists between these variables in Sudan during the period of time investigated.

In Poland, Kotlowski (2005) examines the long run causality behavior between money and prices during the transition period between 1994 and 2003. The study makes use of the monetary inflation model, known as the P-star model that was originally developed by Federal Reserve economists. Using the seasonal cointegration developed by Hylleberg et al. (1990), the results of the study indicate the existence of a long-run causality relationship between money and prices (long-run cointegration relationship), which follows the assumptions of the P-star inflation model. Since the result also indicates that there are no seasonal cointegrating relationships in the P-star inflation model, it can be interpreted as the money demand equation.

Another study (Balogun 2007) examines issues relating to monetary and macroeconomic stability when entering into a monetary union, using data available from the West Africa Monetary Zone (WAMZ) countries. The study tests the hypothesis that independent monetary and exchange rate policies have been relatively ineffective in influencing domestic activities (especially GDP and inflation) and when these policies seem to be effective, their impacts may not be helpful for economic activities. The results show that domestic monetary policy, as captured by money supply and credit to government, hurts the real domestic output of these countries. Interestingly, rather than promoting growth, the domestic monetary policy appears to be a source of stagnation. The results also demonstrate that although expansion in domestic output dampens aggregate consumer prices (inflation), it is not sufficient to dampen the fuelling effects of past inflation. This is highlighted by money supply variables (MS2) and exacerbated by exchange rate variables, which are mostly positive, confirming the prior expectations that rapid monetary expansion and devaluations fuels domestic inflation.

Generally speaking, macroeconomic variables – such as aggregate demand or national income; money supply; and prices, including exchange rates and consumer price indices – are important variables to consider when analyzing the economic performance of a country. The interdependence and interactions between these variables largely determines the movements of the economy, particularly in relation to the growth path desired by the government and other development partners. The debates on the role played by money in any economy remains largely inconclusive, as there are several strands of literature in this regard. Keynesian economists postulate that money does not play an important role in determining income and prices, as changes in income necessitate changes in money stock through a higher demand for money. The monetarists, at the other extreme, postulate that money is all that matters in determining income and prices and opine that money plays a crucial role in determining the level of income and prices in the economy. In other words, changes in income and prices in an economy are primarily due to changes in money stocks. Therefore, the direction of causation runs from money to income and prices without any feedback.

Utilizing data from the United States, Sims (1972) tests for causality between money and income using the Granger causality approach. The results provide evidence supporting the claim that causality runs from money to income, providing empirical support for the monetarists' view. However, other evidence is not necessarily supportive of the monetarist's view. For instance, Lee and Li (1983), in a similar strand, examine the causal relationship between money, income and prices in Singapore and find evidence that supports the existence of bi-directional causalities between money and income and unidirectional causality between money and prices. In the case of India, Joshi and Joshi (1985) examine causalities between income, money and prices, finding that a bi-directional causality exists between money and income. Abass (1991) examines the causality between money and income for selected Asian countries and finds bi-directional causalities in the cases of Pakistan, Malaysia and Thailand. Theoretical issues, based on the extension of the classical Quantity Theory of money, are examined by Fisher and Seater (1993), Grauwe and Polan (2005) and King and Watson (1997), whose works form a large quantum of the literature regarding theoretical issues underpinning the relationship between income and money in an extended model.

Based on the literature review, it may be surmised that money, income and macroeconomic prices play a very important role in any economy. Additionally, they may represent important variables in the measurement of a country's economic health. As asserted by the Federal Reserve Bank of New York (1962), "A country is known by the money it keeps. Healthy money and healthy economy as a rule go hand in hand". The state of a country's economic health is determined primarily by the country's monetary variables. The influence of a monetary policy on the economy as a whole, as well as the channel through which the monetary policy is transmitted, translates into concrete effects on the economy.

RESEARCH METHODOLOGY

This study employs the multivariate cointegration analysis and Granger causality test within the framework of an error correction model to analyze the causal relationship between money supply and macroeconomic variables in Nigeria using annual time series data from 1960 to 2011. There are five variables included in the analysis; nominal money supply, measured by narrow money (M1) and broad money (M2); output, measured by real gross domestic product (GDP); nominal exchange rate (EXH), measured by

the domestic currency/US Dollars (EXH); price, measured by the consumer price index (CPI); and nominal interest rate, measured by prime lending rate (INT). All variables are transformed into logarithms, except interest rate which is already provided in the form of percentage. The model expresses the logarithms of output (LGDP) as a function of logarithms of narrow money (LM1), price (LCPI), exchange rate (LEXH), broad money (LM2) and, finally, interest rate (INT). The methodology adopted in this paper follows that used by Erjavec and Boris (2003), Sjuib (2009), Ghazali et al. (2008) and Masih and Masih (1996). All of these studies examine the dynamic causal chain among macroeconomic variables, such as output, money, interest rate, price and exchange rate. Masih and Masih (1996) examine the dynamic causal relationship among macroeconomic activity, such as real output, money, interest rate, inflation, and exchange rate, in both Malaysia and Thailand using annual data from 1955 to 1991. Erjavec and Boris (2003) investigate the causal relationship between money and macroeconomic variables in Croatia using monthly data from 1994:10 to 2001:10. Ghazali et al. (2008) examine the relationship between money and price in Malaysia using monthly data from January 1974 to September 2006, whereas Sjuib (2009) investigates the causal relationships between macroeconomic variables in Indonesia using annual data from 2001 to 2008.

The data for this study is principally obtained from the Central Bank of Nigeria (CBN) statistical bulletin and Nigeria Bureau of Statistics (NBS). The analysis starts with descriptive statistics and stationarity tests, followed by the multivariate cointegration test developed by Johansen (1988) and Johansen and Juselius (1990); the Granger causality test in vector error correction model (VECM); impulse response function (IRF); and variance decomposition (VDC) method. A stationary series can be defined as one with a constant mean, constant variance and constant auto covariance for each given lag. Unit root tests are important to observe the stationarity of time series data, preventing a spurious regression that results from the use of non-stationary data. In addition, in models with unit roots, shocks (which may be due to policy changes) have persistent effects that last forever, while, in the case of stationary models, such shocks can only have a temporary effect. This study utilizes the two frequently used tests of Augmented Dickey-Fuller and Phillips–Perron on the individual stochastic structures of the time series.

Next, this study conducts the cointegration test, the main purpose of which is to examine the existence of a long run relationship between the variables. According to Granger, if there is evidence of cointegration between two or more variables, then a valid error correction model should also exist between the two variables. Granger (1969, 1986, 1988) and Sim (1972) further state that if two variables are co-integrated, causality must exist in at least one direction. In short, a co-integration indicates the presence of Granger causality, but it does not indicate the direction of causality between the co-integrated variables. The direction of the causality can be detected through the VECM, derived from the long run cointegrating vectors. We employ the Johansen (1988) and Johansen and Juselius (1990) approach to determine whether any of the variables are co-integrated.

In Granger causality, the statistical significance of the t-tests of the lagged error-correction term(s) will imply a long-term causal relationship, while the non-significance of the lagged error-correction terms will affect the long-term relationship and may be a violation of theory. The F-test of the explanatory variables (first differences) indicates the short-run causal effects. The non-significance of both the t-test(s), as well as the F-tests in the VECM, will indicate the econometric exogeneity of the dependent variables. VECM assists in determining the Granger exogeneity or endogeneity of the dependent variable and also assists in understanding the Granger causality within the sample period. However, the VECM provides no indication of the dynamic properties of the system or the relative strength of the variables beyond the sample period (Masih et al. 1996). These shortfalls can be addressed by utilizing VDCs and IRFs.

VDCs indicate the percentage of forecast error variance for each variable that can be explained by its own shocks and by fluctuations in the other variables. VDCs may be termed as causality tests outside the estimation time period (Bessler & Kling 1985). VDCs decompose variations in an endogenous variable into the component shocks to the endogenous variables in the VAR. The Choleski decomposition method is used to orthogonalize all innovation/error, though the method is very sensitive and influenced by the order of variables. For this study, the order is chosen based on previous studies by Erjavec and Boris (2003), Sjuib (2009), Ghazali et al. (2008) and Masih and Masih (1996). The order used is output (GDP), money supply (M1 or M2), interest rate (INT), price (CPI) and, finally, exchange rate (EXH). Since the ordering of the variables is identified, there is no need for a generalized impulse response functions (GIRFs).

Like the VDCs, the IRFs are obtained from the moving average model from the unrestricted VAR model. IRFs trace out the responsiveness of the dependent variables in the VAR to shocks on each of the variables. In order to trace out the dynamic effects of various shocks, the estimated VECM is re-parameterized to its equivalent formulation in levels. The re-parameterized error correction terms are incorporated into the first period lagged terms of autoregression. The model is then inverted to obtain the IRF, in order to capture the effects of deviations from long run equilibrium on the dynamic path, followed by a variable in response to initial shocks. The IRF shows how the future path of those variables changes in response to shocks.

RESULTS

Table 1 reports the descriptive statistics of the variables used in the estimation. The consumer price index (CPI) average is 40.892, varying considerably from a minimum price of 0.138 to a maximum price of 225.4. This represents an increment in price of over 500 percent between 1960 and 2011. The exchange rate (EXH) average is NGN36.1 (Nigerian Naira) to the USD and ranges from a minimum of NGN0.544 to a maximum of NGN156.2. The trend in the exchange rate from 1960 to 2011 indicates a devaluation of the NGN in relation to the USD of over 240 percent, with a standard deviation of 54.8. Interest rates are an average of 13.361 percent, with a minimum of 6.00 percent and maximum of 29.80 percent. The real gross domestic product (GDP) mean is NGN228,020.2 million, with a minimum of NGN2489 million and a maximum of NGN835,086.1 million. The narrow money (M1) average is 699,926.4 million, with a minimum of 217.606 million and maximum of 6,768,426 million, while the broad money (M2) mean is 1,328,969 million, with a minimum of 272.396 and a maximum of 13,300,339. Broad money (M2) has the highest average of 1,328,969 million, followed by narrow money (M1), with an average of 699,926.4 million.

TABLE 1. Descriptive statistics

Variables	CPI	EXH	RGDP	INT	M1	M2
Mean	40.89207	36.11268	228,020.2	13.36053	699,926.4	1,328,969.
Median	1.981154	2.158100	205,014.3	11.50000	13,719.20	26,833.70
Maximum	225.4000	156.2000	835,086.1	29.80000	6,768,426.	13,300,339
Minimum	0.139026	0.544500	2,489.000	6.000000	217.6060	272.3960
Std. Dev.	65.96283	54.89190	233,042.5	6.651265	1,561,144.	3,108,640

The results of the stationarity test in Table 2 indicate that all variables are stationary at first difference in both Augmented Dickey-Fuller test and Phillips–Perron test. Since the variables are integrated with order $I(1)$, we test whether there is a long run relationship between the variables using the Johansen co-integration test (see Table 3). If cointegration exists among the variables, VECM will be the better model specification. Prior to testing for the cointegration, we examine the lag order based on several selection criteria.

TABLE 2. Results of the unit root tests

Variables	Augmented Dickey-Fuller		Phillips–Perron	
	Constant without Trend	Constant with Trend	Constant without Trend	Constant with Trend
Levels				
LGDP	-1.0583	-1.3158	-1.0645	-1.3427
LM1	1.3296	-2.9095	1.1023	-2.7221
LM2	0.5936	-3.0544	1.2039	-2.7133
INT	-1.3146	-1.7939	-1.7841	-3.1411
LCPI	-0.0738	-1.6343	0.2019	-1.7274
LEXH	0.4387	-1.9058	0.2543	-1.9602
First Differences				
ΔLGDP	-6.4955	-6.4998	-6.4809	-6.4852
ΔLM1	-4.8445	-4.8942	-4.8291	-4.8437
ΔLM2	-4.7178	-4.7652	-4.5669	-4.5649
ΔINT	-11.2464	-11.1450	-11.2912	-11.2099
ΔLCPI	-5.3616	-5.2976	-5.4136	-5.3514
ΔLEXH	-5.9038	-5.9849	-5.9339	-5.9779

Notes: Abbreviations L refers to logarithm and Δ refers to change

MULTIVARIATE COINTEGRATION ANALYSIS

The lag selection criterion for both M1 and M2 is based on the likelihood ratio test (LR), Akaike Information Criterion (AIC), and Hannan-Quinn Information criterion (HQ). The results, as reported in Table 3 for both models, indicate that a 7 year lag length is more appropriate. Note that results (without significance) for several periods are omitted to conserve space. The next step is to conduct the cointegration test among the variables, the results of which are reported in Table 4.

TABLE 3. Lag order selection criteria

Lag	Loglikehood	LR	FPE	AIC	SC	HQ
Panel A. For GDP, M1, CPI, INT and EXH						
0	-177.3898	NA	0.002281	8.106212	8.306952	8.181046
6	306.3578	45.35159*	3.96e-09	-6.727012	-0.504063	-4.407159
7	389.8795	33.40870	1.21e-09*	-9.327979*	-2.101329*	-6.633956*
Panel B. For GDP, M2, CPI, INT and EXH						
1	97.49526	479.3200	3.45e-08	-2.999789	-1.795347*	-2.550785
6	293.9407	41.01515*	6.88e-09	-6.175143	0.047805	-3.855291
7	359.3446	26.16153	4.71e-09*	-7.9708*	-0.744219	-5.276847*

Notes: * indicates lag order selected by the criterion, each is tested at 5% significance level. Abbreviations LR = sequential modified likelihood ratio test statistic, FPE = final prediction error, AIC = Akaike information criterion, SC = Schwarz information criterion and HQ = Hannan-Quinn information criterion.

TABLE 4. Johansen's test for multiple cointegrating vectors

Null	Alternative	Maximum Eigenvalue	Critical Value 95%	Trace	Critical Value 95%
Panel A. Variables (LGDP, LM1, INT, LCPI, LEXH (p = 2))					
r = 0	r > 0	36.19643*	33.46	80.10386**	68.52
r ≤ 1	r > 1	18.41736	27.07	43.90743	47.21
r ≤ 2	r > 2	16.50658	20.97	25.49007	29.68
r ≤ 3	r > 3	8.981914	14.07	8.983486	15.41
r ≤ 4	r = 5	0.001573	3.76	0.001573	3.76
Panel B. Variables (LGDP, LM2, INT, LCPI, LEXH (p = 2))					
r = 0	r > 0	33.78463*	33.46	75.16723*	68.52
r ≤ 1	r > 1	17.94062	27.07	41.38260	47.21
r ≤ 2	r > 2	15.04672	20.97	23.44198	29.68
r ≤ 3	r > 3	8.268127	14.07	8.395260	15.41
r ≤ 4	r = 5	0.127134	3.76	0.127134	3.76
BETA (Transposed)					
LGDP	LM1	INT	LCPI	LEXH	
1.000	1.083680	0.019848	-0.620641	-0.157503	
LGDP	LM2	INT	LCPI	LEXH	
1.000	0.875078	0.006491	-0.293212	-0.190156	
Testing restriction on beta:					
BETA (Transposed)					
LGDP	LM1	INT	LCPI	LEXH	
1.000	0.000000	-0.456418	-1.770924	5.136359	
LGDP	LM2	INT	LCPI	LEXH	
1.000	0.000000	0.498278	5.219892	-7.877268	

Notes: r value indicates the number of co-integrating vectors. ** and * indicates rejection at the 99% and 95% critical values. Symbol p indicates the optimal lag structure for each model

The Johansen multivariate co-integration test results for both M1 and M2 in Table 4 indicate the rejection of the null hypothesis of zero cointegration is at a 95 percent critical level. The test results of both trace and maximum Eigen-value statistics indicate the existence of a long run relationship between the macroeconomic variables.

Table 5 reports the Granger causality results based on VECM with a uniform lag structure of two, as determined by the multivariate minimum AIC. Significant F-statistics indicate that the independent variables Granger cause the dependent variable. The results from Table 5 allow us to make several observations. First, there is a unidirectional short run causal effect running from money supply (both M1 and M2) to interest rate. Second, a causation runs from broad money supply (M2) to price, but none otherwise. Third, the causations that run from price to interest rate and from price to exchange rate are also unidirectional. Fourth, there is a unidirectional short-run causal effect running from narrow money (M1) to exchange rate. Finally, a causation runs from real GDP to exchange rate, but not from exchange rate to real GDP. These findings support the previous study by Masih and Masih (1996) that find a short run causality running from money supply to interest rate, from broad money to price and from price to exchange rate in the Malaysian economy. For the Thai economy, the causality runs from narrow money to exchange rate (Masih & Masih 1996).

TABLE 5. Granger causality tests based on vector error-correction model (VECM)

M1 Model	ΔGDP	ΔM1	ΔINT	ΔCPI	ΔEXH	ECT_{t-1}
D. Variables		F – Statistics (significance levels)				t - statistics
ΔGDP	-	0.1764	0.8915	0.9161	0.8779	-1.1501
ΔM1	0.6534	-	0.4954	0.9222	0.4896	-0.5427
ΔINT	0.1427	0.0564*	-	0.0001***	0.2688	-3.6558***
ΔCPI	0.6123	0.1676	0.4764	-	0.1103	1.2122
ΔEXH	0.0173**	0.0391**	0.2396	0.0046***	-	-4.8134***
M2 Model	ΔGDP	ΔM2	ΔINT	ΔCPI	ΔEXH	ECT_{t-1}
D. Variables		F – Statistics (significance levels)				t - statistics
ΔGDP	-	0.2469	0.8416	0.9665	0.8999	-1.0399
ΔM2	0.6710	-	0.2911	0.9515	0.7130	-0.1787
ΔINT	0.3257	0.0882*	-	0.0004***	0.5292	2.9388***
ΔCPI	0.3209	0.0232**	0.5034	-	0.1133	2.2226***
ΔEXH	0.0323**	0.1582	0.5480	0.0096***	-	4.2716***

Notes: All variables are in the first differences (denoted by Δ) with the exception of the lagged error-correction term ECT_{t-1} which is generated from the Johansen's cointegration test conducted in Table 4. The error-correlation term ECT_{t-1} is derived by normalizing the four cointegration vectors on GDP. Stationarity test is conducted on the residual and is found to be stationary. Different diagnostic tests (provided in the Appendix) conducted for multicollinearity, heteroscedasticity, normality and model specification and all are found to be satisfactory. ***, **, and * indicate significance at the 1%, 5%, and 10% levels respectively.

The presence of causal relationships between the variables demonstrates that money supply is not neutral in the short-run and can be an efficient tool for stabilizing both interest rates and price levels in the Nigeria economy. However, we cannot rule out the significance of the error correction term (ECT_{t-1}), which indicates that the burden of the short run endogenous adjustment (to the long-term trend) to bring the system back to its long-run equilibrium has to be borne by (1) interest rate and exchange rate for narrow money, and (2) interest rate, exchange rate and price for broad money (whose ECTs are highly significant at 1 percent level). This indicates that a long-run causality runs from growth, money supply, interest rate and price, respectively, to exchange rate. Second, a long-run causality runs from growth, money supply, interest rate and exchange rate, respectively, to price. Lastly, a long run causality runs from growth, money supply, price, exchange rate, respectively, to interest rate. The VECM results also show that in the short-run, real GDP and money supply stand out as econometrically exogenous, as evidenced by the statistical insignificance of the t-test of the lagged error correction term (ECT_{t-1}) and F-tests of the independent variables. One major implication of the VECM result is that growth leads the exchange rate in the Nigeria economy.

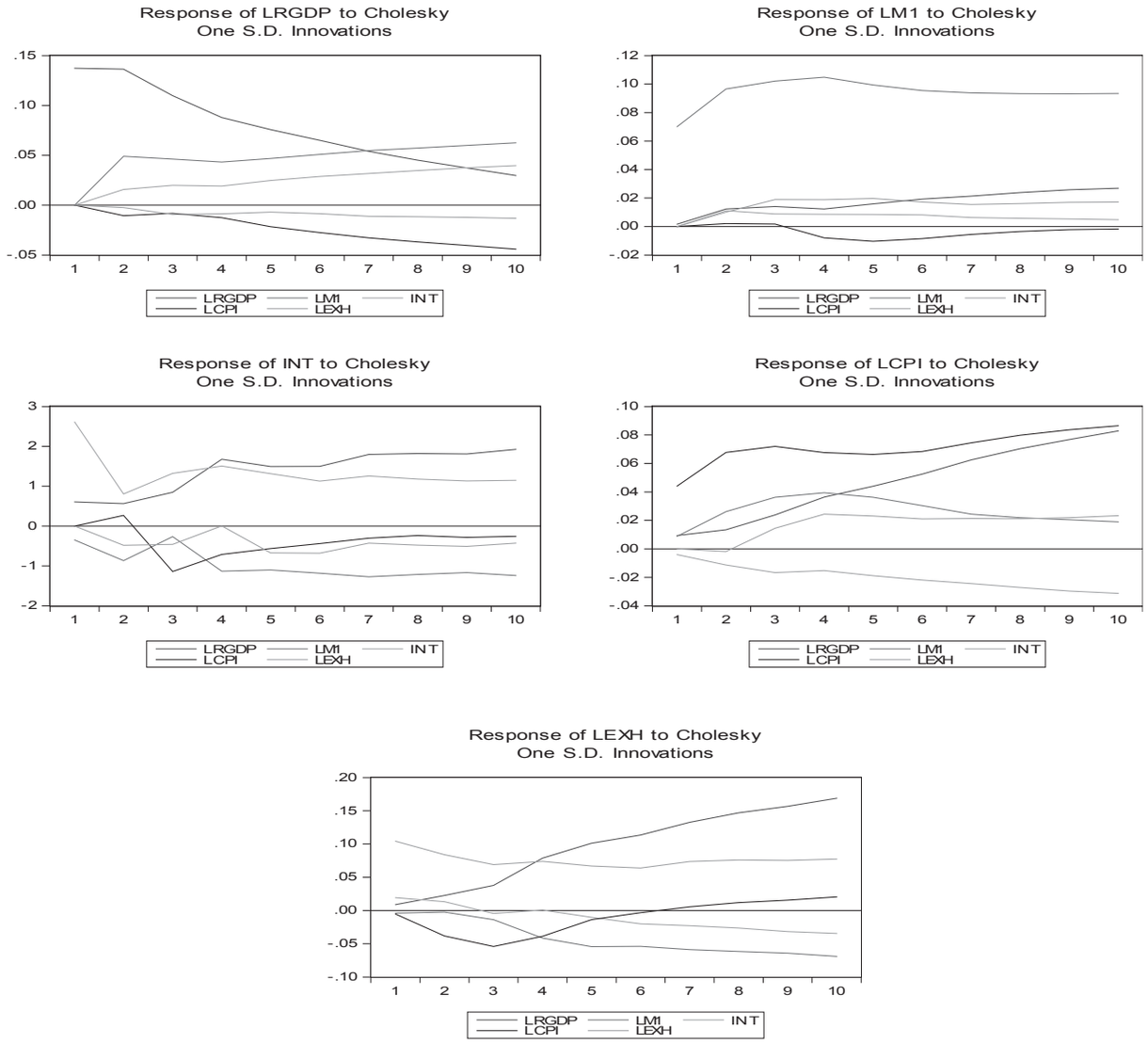

FIGURE 1. Impulse responses of all variables to a one standard deviation shock to LGDP, LM1, LCPI, INT and LEXH

Next, the results of the IRF are presented in Figure 1. A ten year horizon is employed in order to allow the dynamics of the system to work out. Real GDP responds positively to one standard deviation shock in all variables, except prices and exchange. Narrow money responds positively to one standard deviation shock in all variables, except price, after the third period and only begins to stabilize after the eight periods. Price responds positively to one standard deviation shock in all variables, except interest rate, and one standard deviation shock in prices has a negative effect on all variables after the third period, except exchange rate after the sixth period. The interest rate responds to one standard deviation shock in all variables and is statistically significant at 99 percent significant level.

For M2, the responses of real GDP to one standard deviation shock in all variables is positive, except on price after the fourth period and exchange rate after the second period. Broad money (M2) responds positively to one standard deviation shock in all variables, except price. Price also responds positively to one standard deviation shock in all variables, except interest rate. Likewise, one standard deviation shock in interest rate has a positive impact on others variables, except price. Exchange rates respond positively to all shocks, except broad money and price.

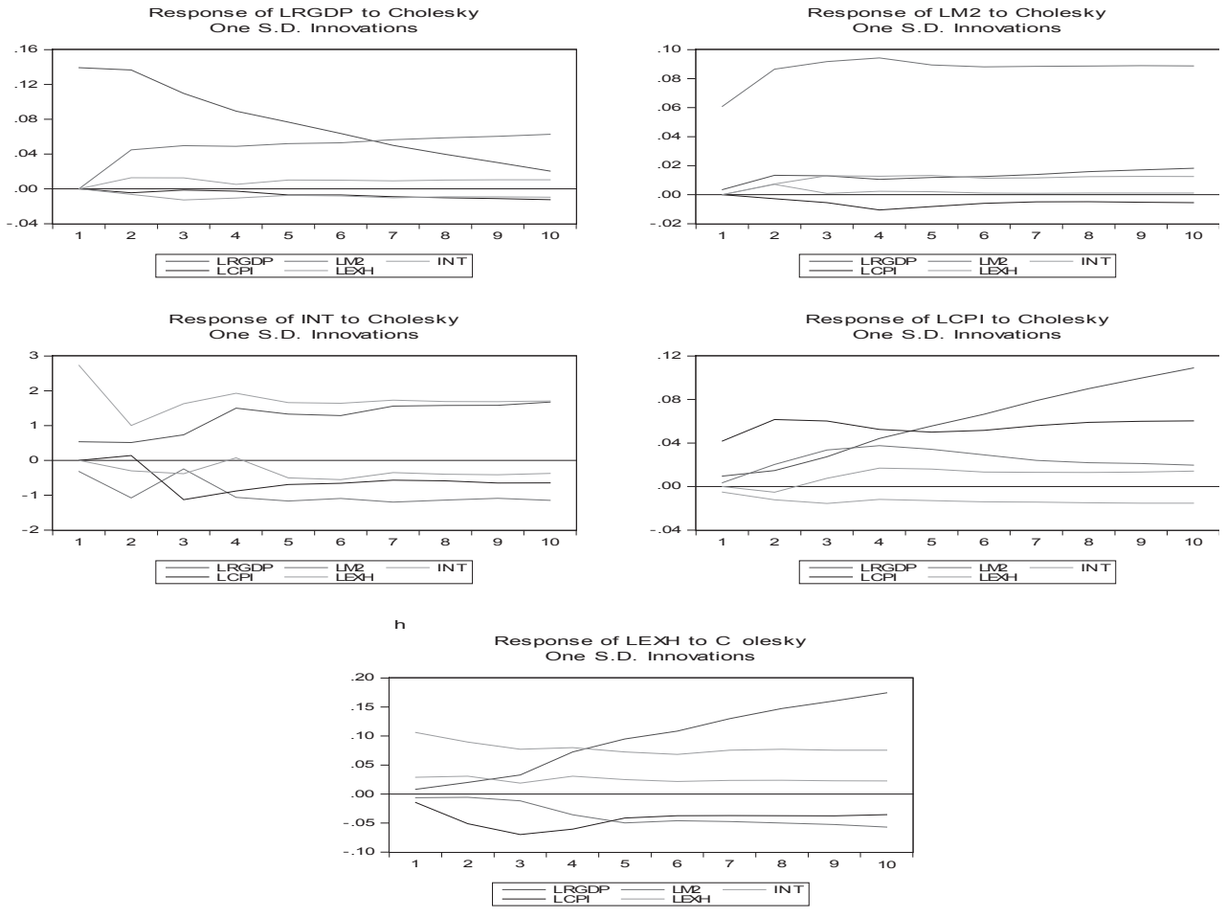

FIGURE 2. Impulse responses of all variables to a one standard deviation shock to \ LGDP, LM2, LCPI, INT and LEXH

Table 6 reports the variance decomposition of the macroeconomic variables only on the tenth month to conserve space. As reported in Panel A, the variance decomposition of GDP indicates that 100 percent of GDP variance can be explained by current GDP in the first period (not reported) and the percentage (64.5%) is still significant at the end of the tenth periods. At the end of the ten year period, money supply (M1) contributes a negligible amount of 21.6 percent to the variation in the forecast error of GDP, while interest rate and price accounts for 6.5 percent and 6.6 percent, respectively, of the variation in the forecast error of GDP. Finally, this analysis indicates no significant relationship between the variance of GDP and exchange rate.

The variance of money supply (M1) reveals that 94.8 percent of the forecast error variance of current money supply (M1) is explained by its own shock after a five year period. A significant part of money supply (M1) variance is caused by current variations in narrow money in the first period and remains significant until the end of the tenth period, reaching 92.79 percent. Exchange rate contributes 2.7 percent of the variation in the forecast error of money supply (M1). Finally, both price and interest rate are not significantly influenced by money supply (M1).

The variance of price (CPI) indicates that about 54 percent of the forecast error variance of current price is explained by its own shock after the ten year period. Both GDP and narrow money accounts for 30 and 8 percent of the variation in the forecast error of price, while exchange rate and interest rate have little significant influence on price. Both exchange rate and price contribute little to the variation in the forecast error of interest rate. The variance of interest rate indicates that 93 percent of the forecast error variance of current interest rate is explained by its own shock in the first month of the shock, but it quickly reduces to 34.6 percent by the tenth month. Finally, the exchange rate has little significant impact on interest rate. About 96 percent of exchange rate forecast error variance is explained by the innovations in the current exchange rate variable, but, like interest rate, its own lagged effect quickly reduces to 27 percent. Real GDP accounts for approximately 57 percent of the variation in the forecast error of exchange rate, while narrow money, price and interest rate, respectively, contribute very little by the end of the ten year period.

TABLE 6. Summary of the variance decomposition indicating the percentage of forecast variance explained by innovation in selected variables

Panel A. M1 model (Order: DLGDP, DLM1, DINT, DLCPI, DLEXH)					
Effect upon	ΔLGDP	ΔLM1	ΔINT	ΔLCPI	ΔLEXH
ΔLGDP	64.45	21.60	6.62	6.56	0.76
ΔLM1	3.66	92.79	0.56	0.31	2.67
ΔINT	38.34	18.66	34.56	4.63	3.82
ΔLCPI	29.56	8.02	4.85	53.71	3.86
ΔLEXH	56.53	10.97	2.06	3.20	27.25
Panel B. M2 model (Order: DLGDP, DLM2, DINT, DLCPI, DLEXH)					
Effect upon	ΔLGDP	ΔLM2	ΔINT	ΔLCPI	ΔLEXH
ΔLGDP	71.71	25.99	0.94	0.57	0.77
ΔLM2	2.31	95.52	0.09	0.45	1.64
ΔINT	26.18	15.73	49.08	6.88	2.13
ΔLCPI	53.16	7.82	2.06	35.23	1.73
ΔLEXH	53.19	7.31	2.74	8.65	28.09

Notes: The alternation of the monetary variables appearing prior to output do not change the results because the variance–covariance matrix of residual are near diagonal, estimated through the Cholesky decomposition in order to orthogonalize the innovations across equation. Only the results on period 10 are reported to conserve space. The detail output of VDC is available from the corresponding author upon request.

Later, Panel B of Table 6 shows that narrow money (M1) and broad money (M2) respectively accounts for 21.6 and 26 percent of the variation in the forecast error of output (GDP) after the ten year period. Respectively, M1 and M2 account for 18.66 percent and 15.73 percent of the variation in the forecast error of interest rate, while M1 and M2 contribute 8.02 and 7.82 percent of the variation in the forecast error of price, respectively. Exchange rate contributes very little to the variation in the forecast error of output (GDP). Price contributes minimally for the variation in the forecast error of money supply (MI and M2), exchange rate and interest rate, respectively. M1 also contributes very little to the variation in the forecast errors of all variables. In general, M2 contributes more to the variation in the forecast error of all variables than narrow money, except in relation to interest rate, price and exchange rate. Considering the definitions of money stocks, broad money appears to have the strongest causal effect on real output with 25.99 percent of forecast error variance, compared with 21.6 percent with narrow money.

CONCLUSION AND IMPLICATIONS

The main objective of this study is to examine the dynamic causal relationship between money and macroeconomic activities that are represented by output, interest rate, price, and exchange rate in the small open economy of Nigeria from 1960 to 2011. The methodology adopted includes the multivariate cointegration test developed by Johansen (1988) and Johansen and Juselius (1990); the Granger causality test in vector error correction model (VECM); impulse response function; and variance decomposition method, which are used to capture Granger causality, both within and outside the sample, among macroeconomic activities.

The results of the cointegration test indicate that a long run relationship exists between the macroeconomic variables. This implies that these (co-integrated) variables will have short-term or transitory deviations (or departures) from their long term common trend (s), and eventually forces will be set in motion that will drive them together again. The empirical results of this study show that money supply is not neutral in the short-run and is efficient in stabilizing both the interest rate and price level in the Nigeria economy. The variation in price level is mainly caused by its own lagged values, output and exchange rate, while the variation in output is caused by its own lagged value, exchange rate and price.

The results of the relative contribution of the explanatory variables in explaining the variation in the dependent variable in the post sample era confirm the conclusion obtained from within the sample by VECM analysis. In regards to money stocks, broad money (M2) contributes more to the variation in the forecast error of all variables than narrow money (M1), except in the case of interest rate, price and exchange rate. In contrast to most previous studies, the VDC results show that money supply contains better information about the source of shocks affecting the economy than other variables. Money supply is therefore helpful in predicting the current and future growth rate output and prices in Nigeria economy. Thus, if the main objective of the government is to sustain high economic growth rate, exchange rate targeting will be the most suitable measure to adopt. However, if the

objective of the government is to curb the inflation rate, monetary policy targeting has a more causal effect on price in relation to narrow money than broad money. The Granger causal chain demonstrated by our findings is more consistent with the quantity theory of money than other economic paradigms. However, monetary policy alone is insufficient to achieve sustainable economic growth and price stability.

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Tajudeen Mukhtar Olatunji (corresponding author)
School of Economics, Faculty of Economics and Management
Universiti Kebangsaan Malaysia
43600 UKM Bangi, Selangor, Malaysia
E-mails: olatmukhtar500@yahoo.com

Adedokun Adebayo Sunday
Department of Economics, Faculty of Social Science
University of Lagos, Unilag Post Office 265
Akoka, Lagos, Nigeria
E-mails: brobayunilag@gmail.com

Yaqub Jameelah Omolara
Department of Economics, Faculty of Social Science
University of Lagos, Unilag Post Office 265
Akoka, Lagos, Nigeria
E-mails: tyaqub2003@yahoo.com

APPENDIX

DIAGNOSTIC TEST RESULTS

TABLE A1. Test of multicollinearity

INT	LCPI	LEXH	LM1	LM2	LRGDP
1.000000	0.784487	0.806334	0.749881	0.750349	0.770986
0.784487	1.000000	0.968248	0.986567	0.984073	0.894461
0.806334	0.968248	1.000000	0.935089	0.930879	0.799695
0.749881	0.986567	0.935089	1.000000	0.999577	0.929005
0.750349	0.984073	0.930879	0.999577	1.000000	0.934470
0.770986	0.894461	0.799695	0.929005	0.934470	1.000000

Notes: The result shows the absence of multicollinearity except in the case of LM1 and LM2 and can be ignored since the research treat both variables separately.

TABLE A2. VEC residual normality tests

Component	Skewness	Chi-sq	Df	Prob.
1	3.443949	96.86310	1	0.0000
2	0.041693	0.014196	1	0.9052
3	-0.198562	0.321985	1	0.5704
4	-0.067806	0.037547	1	0.8464
5	1.877293	28.78120	1	0.0000
	Joint	126.0180	5	0.0000
Component	Kurtosis	Chi-sq	Df	Prob.
1	17.97797	458.0264	1	0.0000
2	2.712422	0.168848	1	0.6811
3	4.407838	4.046597	1	0.0443
4	3.665364	0.903865	1	0.3417
5	9.108204	76.17489	1	0.0000
	Joint		539.3206	5
Component	Jarque-Bera	Df	Prob.	
1	554.8895	2	0.0000	
2	0.183044	2	0.9125	
3	4.368582	2	0.1126	
4	0.941412	2	0.6246	
5	104.9561	2	0.0000	
	Joint	665.3387	10	

TABLE A3. VEC residual heteroscedasticity tests

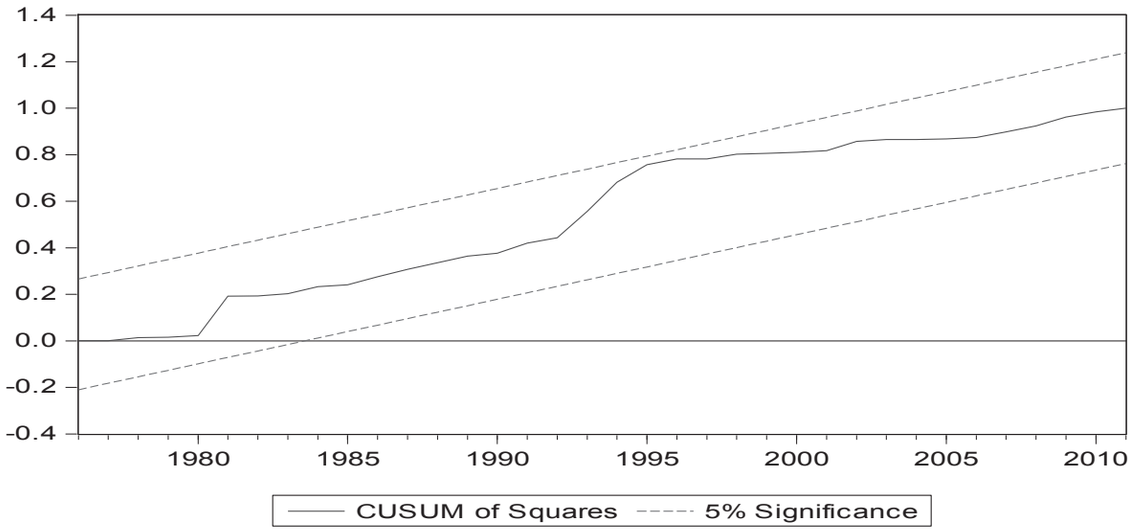
Individual components:					
Chi-sq	Df	Prob.			
337.0145	330	0.3832			
Dependent	R-squared	F(22,26)	Prob.	Chi-sq(22)	Prob.
res1*res1	0.518348	1.271859	0.2764	25.39906	0.2784
res2*res2	0.532671	1.347061	0.2318	26.10088	0.2474
res3*res3	0.686946	2.593307	0.0107	33.66035	0.0532
res4*res4	0.475031	1.069399	0.4311	23.27654	0.3863
res5*res5	0.534838	1.358842	0.2255	26.20707	0.2429
res2*res1	0.344764	0.621835	0.8694	16.89345	0.7692
res3*res1	0.362041	0.670682	0.8277	17.74003	0.7213
res3*res2	0.315992	0.545966	0.9233	15.48361	0.8407
res4*res1	0.536483	1.367858	0.2207	26.28767	0.2395
res4*res2	0.506204	1.211515	0.3171	24.80400	0.3065
res4*res3	0.558500	1.495007	0.1623	27.36650	0.1976
res5*res1	0.421207	0.860047	0.6375	20.63913	0.5431
res5*res2	0.463857	1.022480	0.4740	22.72902	0.4172
res5*res3	0.516667	1.263323	0.2819	25.31667	0.2822
res5*res4	0.486082	1.117808	0.3894	23.81804	0.3568

Notes: Sample: 1960 2011 Included observations: 49 Joint test. We accept the null hypothesis of Homoskedasticity.

TABLE A4. VEC residual portmanteau tests for autocorrelations

Null Hypothesis: no residual autocorrelations up to lag h					
Lags	Q-Stat	Prob.	Adj Q-Stat	Prob.	Df
1	7.416398	NA*	7.570906	NA*	NA*
2	14.32049	NA*	14.76879	NA*	NA*
3	41.02193	0.6411	43.21163	0.5480	45
4	62.98447	0.7113	67.12640	0.5752	70
5	90.79272	0.6031	98.09468	0.3934	95
6	119.3955	0.4984	130.6886	0.2379	120
7	140.3847	0.5928	155.1759	0.2666	145
8	162.9979	0.6364	182.2015	0.2475	170
9	181.2742	0.7511	204.5899	0.3045	195
10	214.4326	0.5932	246.2505	0.1082	220

Notes: Sample: 1960 2011 Included observations: 49 Joint test.



Panel B. M2 model

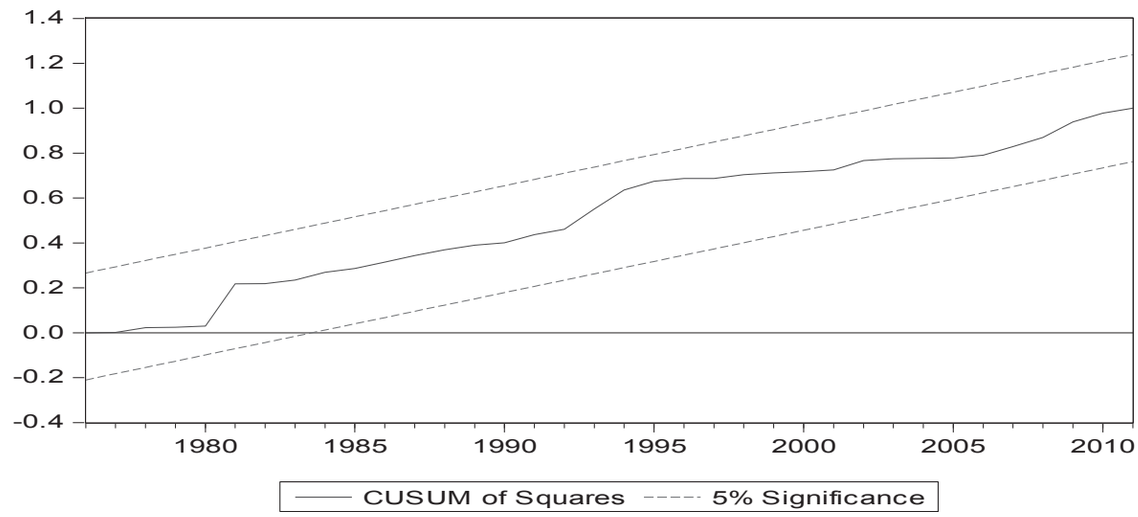


FIGURE A1. CUSUM test