The Quantity Theory of Money and Its Long Run Implications: Empirical Evidence from Nigeria

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June 2012

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Abstract

The Quantity Theory of Money (QTM) is one of the popular classical macroeconomic models that explain the relationship between the quantity of money in an economy and the level of prices of goods and services. This study investigates this relationship for Nigeria economy over the period of 1960 to 2009. To check the stationarity properties, we employed Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) test and found all the concerned variables are stationary only in the first differenced form. Using Johansen cointegration method, the empirical findings indicate that there exists long run cointegrating relationship among the concerned variables. Then applying the Granger causality test, we found a unidirectional causal relationship running from money supply to inflation which provides evidence in support for monetarist's view. In addition, this study does not provide evidence in supporting the well known fisher effect for Nigeria. Causality does not strictly run from inflation to interest rates as suggested by the Fisher hypothesis, instead a reversed causality between the variables is found. We finally used Wald test to verify the restrictions imposed on money aggregates and output, and we concluded and confirmed the proposition of quantity theory of money that inflation is a monetary phenomenon.

Keywords: Quantity Theory of Money, Co-integration, Nigerian Economy.

Introduction

The quantity theory of money is one of the oldest surviving economic doctrines. Simply stated, it asserts that changes in the general level of general prices are determined primarily by changes in the quantity of money in circulation. The quantity theory of money

formed the central core of 19th century classical monetary analysis, provided the dominant conceptual framework in contemporary financial events. Considering the adverse impacts of inflation on the economy, there is a consensus among the worlds' leading central banks that the price stability is the prime objective of monetary policy [King (1999); Blejer, et al. (2000); Cecchetti (2000)] and the central banks are committed to maintain low inflation [Goodfriend (2000); Qayyum (2006)].

Several empirical studies across the world have explored the relationship between inflation and other macro economic variables using cross sectional and time series data for both developed and developing countries, for example, Emerson (2006), Moosa (1997), Miyao (1996), Moazami and Gupta (1996), Duck (1993), Amin (2011)and Karfakis (2002). Despite having several empirical works regarding the causality between money and price across the globe, few researchers make attempt to investigate this relationship in Sub-Saharan Africa and Nigeria. So far in my knowledge, there are few studies which test the validity of the quantity theory of money in Nigeria among which are; Anoruo (2002), Nwaobi (2002), Fielding (1994), Nwafor (2007) and Omanukwue (2010).

In Anoruo, the stability of the M2 money demand function in Nigeria during the structural adjustment program period was investigated using the Johansen and Juselius cointegration method. The finding suggests that there is a long run relationship existing between M2, and real discount rate, and output and concluded that demand is stable during the study period. Nwaobi (2002) applying the Johansen cointegration technique with data from 1960-95, found that money supply, real GDP, inflation, and interest rate are cointegrated in the Nigerian case while Nwafor (2011) using Johansen Juselius cointegration procedures provide support for the long run aggregate money demand in Nigeria in accordance with the Keynesian liquidity preference theory (LPT) and concluded that the stability of M2 is deemed necessary as a monetary policy tool to effect economic activity in Nigeria.

Omanukwue (2010) used the Engle-Granger two–stage test for cointegration to examine the long-run relationship between money, prices, output and interest rate and ratio of demand deposits/time deposits (proxy for financial development) and found evidence of a long-run relationship in line with the quantity theory of money. According to him, restrictions imposed by the quantity theory of money on real output and money supply do not hold in an absolute sense and his study established the existence of "weakening" uni-directional causality from money supply to core consumer prices in Nigeria.

Deviating from earlier studies, this paper draws on recent developments in the theory of econometric techniques to test whether the QTM holds as a long run equilibrium relation in Nigeria. The empirical relationships that we set to examine are the following:

1. Is there a long run equilibrium relationship between money and prices in Nigeria?
2. Is causality running in either direction or both directions?
3. Finally, we want to test the joint hypothesis that the quantity of money has a direct and proportionate effect on the price level and the volume of output has a negative and inversely proportionate effect on the price level.

In recent times, many economies of world are transiting to an inflation targeting framework as against exchange rate and monetary targeting frameworks in order to achieve macroeconomic objectives of price stability, economic growth, balance of payment viability as well as employment creation in its conduct of monetary policy. Thus, this study is important as the relationship between money and prices under quantity theory of money will provide a clearer picture which will aid the Central Bank of Nigeria in its quest for the most reliable and effective monetary policy framework

This article is organized as follows. Next section is devoted to the theoretical background. Then the following section discusses the data and methodology. Results and their interpretation follow in the subsequent section with concluding remarks.

The Oretical Frame Work

The quantity theory had a rich and varied tradition, going as far back as the eighteenth century. It is the proposition that in long-run equilibrium, a change in the money supply in the economy causes a proportionate change in the price level, though not necessarily in disequilibrium. The quantity theory was dominant in its field through the nineteenth century, though more as an approach than a rigorous theory, varying considerably among writers like John Locke, David Hume, Richard Cantillon, David Ricardo, John Wheatley, Irving Fisher, A.C. Pigou and Knut Wicksell for the classical period in economics. Modern versions of the quantity theory are often associated with Knut Wicksell (1898, 1906) and Irving Fisher (1911).

Irving Fisher, in his book *The Purchasing Power of Money* (1911), sought to provide a rigorous basis for the quantity theory by approaching it from the quantity equation.

With two different ways of measuring expenditures, there will arise these identities;

$$Y \equiv MV$$
$$Y \equiv Py$$
$$\text{Hence, } MV \equiv Py \qquad \qquad (1)$$

where:

y = real output (of commodities)

P = price level (i.e. the average price level of commodities)

Y = nominal value of output ($\equiv$ nominal income)

M = money supply

V = velocity of circulation of money (M) against output (y) over the designated period.

Equation (1) is an identity since it is derived solely from identities. It is valid under any set of circumstances whatever since it can be reduced to the statement: in a given period, by a given group of people, expenditures equal expenditures, with only a difference in the computational method between them.

He recognized Equation (1) as an identity and added assumptions to it to transform the quantity equation into a theory for the determination of prices. To transform the quantity equation into the quantity theory, Fisher put forth two propositions about economic behavior. These are: (i) the velocities of circulation of "money" and deposits depend on technical conditions and bear no discoverable relation to the quantity of money in circulation. In other words, it depends on countless individual rates of turnover which depend also on individual habits, density of population, commercial customs, rapidity of transport, and other technical conditions, but not on the quantity of money and deposits, nor on the price level. (ii) the volume of trade, like the velocity of circulation of money, is independent of the quantity of money.

Fisher was certainly right in specifying that the transformation from his version of the quantity equation to the quantity theory requires that, when the monetary authorities increase the amount of money, the velocity of circulation and the quantities of goods remain unchanged. These assertions, as well as (i) and (ii) above, are economic ones, resting on assumptions about human behavior, and may or may not be valid.

We can rewrite the QTM equation in terms of percentage rates of change (in terms of the growth rates):

$$m_t + v_t = p_t + y_t \qquad\qquad (2)$$

where p is the natural logarithm of the price level, y is the natural logarithm of real output, m is the natural logarithm of the money stock, and v is the natural logarithm of the velocity of money.

The simplest way of converting this identity into a testable theory is to assume that the velocity of money is constant. This paper makes the natural logarithm of the velocity of money a function of the nominal interest rate as suggested by Emerson (2006):

$$v_t = \psi_0 + \psi_1 i_t + \varepsilon_t \qquad\qquad (3)$$

where i is nominal interest rate, ψ_0 and ψ_1 are coefficients and εt is a random error. Combining and re-arranging equations (2) and (3) gives

$$p_t = m_t + \psi_0 + \psi_1 i_t + \varepsilon_t - y_t \qquad (4)$$

Many works treat output and the quantity of money (and their growth rates) as exogenous variables (see for example, Duck (1993)). In that case, we could just estimate equation (4). Without restrictions on the variables, that the intercept is zero, the coefficient of money supply is plus one, and the coefficient of real GDP is minus one, the following model is estimated:

$$p_t = \lambda_0 + \lambda_1 i_t + \lambda_2 m_t + \lambda_3 y_t + \varepsilon_t \qquad\qquad (5)$$

The definitions of the variables are given in the data section of the paper. After estimating the long-run relationship represented by (5), the main implications of the quantity theory of money can be tested.

Data and Methodology

The study uses long and up-to-date annual time-series data (1960-2009), with a total of 50 observations for each variable (price index, nominal interest rate, money supply and real GDP). Lucas (1980) argues the importance of choosing the appropriate monetary aggregate which corresponds to the variable theoretically termed "money". We use broad money supply,

i.e., M2 monetary aggregate (m) as a sum of M1 monetary aggregate plus time deposits in the banking system. We use money market interest rate as proxy for nominal interest variable (i) and Price measures are based on consumer price index (p). Finally, the real GDP data are used for real income variables (y). The data for the study are obtained from Central Bank of Nigeria Statistical Bulletin and Annual Report and Statements of Account for different years. We therefore estimate Equation (5) using the ordinary least square (OLS) method. The software application utilized was E-views 7.0.

Therefore we re-specify equation (5) as;

$$PRINDEX_t = \lambda_0 + \lambda_1 NOMINT_t + \lambda_2 MONEY2_t + \lambda_3 REALINCO_t + \varepsilon_t \qquad (6)$$

where $PRINDEX_t$, $NOMINT_t$, $MONEY2_t$, $REALINCO_t$ and ε_t are price index, nominal interest rate, money supply, real GDP and error term respectively. We start by first examining the stationarity of our variables, price index, nominal interest rate, money supply and real GDP. A non-stationary time series has a different mean at different points in time, and its variance increases with the sample size (Harris and Sollis (2003). A characteristic of non-stationary time series is very crucial in the sense that the linear combinations of these time series make spurious regression. In the case of spurious regression, t-values of the coefficients are highly significant, coefficient of determination (R2) is very close to one and the Durbin Watson (DW) statistic value is very low, which often lead investigators to commit a high frequency of Type 1 errors (Granger and Newbold, 1974). In that case, the results of the estimation of the coefficient became biased. Therefore it is necessary to detect the existence of stationarity or non-stationarity in the series to avoid spurious regression. For this, the unit root tests are conducted using the Augmented Dickey-Fuller (ADF) test and Philips-Perron (PP). If a unit root is detected for more than one variable, we further conduct the test for cointegration to determine whether we should use Vector Error Correction methodology.

Nelson and Plosser (1982) indicate that many macroeconomic time series data have a stochastic trend plus a stationary component, that is, they are difference stationary processes. It is also of great importance to discern the temporary and permanent movements in an economic time series. Economic theory in this line assumes that at least some subsets of economic variables do not drift through time independently of each other and some combination of the variables in these subsets reverts to the mean of a stable stochastic process. Granger (1986) and Engle and Granger (1987) indicate that even though economic

time series may be non-stationary in their level forms, there may exist some linear combination of these variables that converge to a long run relationship over time, which also requires the existence of Granger causality in at least one direction in an economic sense as one variable can help forecast the others.

Cointegration therefore can be defined simply as the long-term, or equilibrium, relationship between/among series. The cointegration method by Johansen (1991; 1995) has become the most cited cointegration technique and is used in this study. The Vector Autoregression (VAR) based cointegration test methodology developed by Johansen (1991; 1995) is described as follows;

The procedure is based on a VAR of order p:

$$y_t = A_1\, y_{t-1} + ... + A_p\, y_{t-p} + Bz_t + \varepsilon_t \qquad (7)$$

where y_t is a vector of non-stationary I(1) variables, z_t is a vector of deterministic variables and ε_t is a vector of innovations. The VAR may therefore be reformulated as:

$$\Delta y_t = \Pi\, y_{t-1} + \sum_{i=1}^{p-1} + \Gamma_i\, \Delta y_{t-p} + Bz_t + \varepsilon_t \qquad (8)$$

$$\text{where } \Pi = \sum_{i=1}^{p} A_i - I \qquad (9)$$

$$\text{and } \Gamma_i = \sum_{j=i+1}^{p} A_j \qquad (10)$$

Estimates of Γ_i contain information on the short-run adjustments, while estimates of Π contain information on the long-run adjustments, in changes in y_t. The number of linearly dependent cointegrating vectors that exist in the system is referred to as the cointegrating rank of the system. This cointegrating rank may range from 1 to n-1 (Greene 2000:791). There are three possible cases in which $\Pi y_{t-1} \sim I (0)$ will hold. Firstly, if all the variables in y_t are I (0), this means that the coefficient matrix Π has r=n linearly independent columns and is referred to as full rank. The rank of Π could alternatively be zero: this would imply that there are no cointegrating relationships. The most common case is that the matrix Π has a reduced rank and there are $r<(n-1)$ cointegrating vectors present in β. This particular case can be represented by:

$$\Pi = \alpha\beta' \qquad\qquad\qquad (11)$$

where α andβ are matrices with dimensions n x r and each column of matrix α contains coefficients that represent the speed of adjustment to disequilibrium, while matrix β contains the long-run coefficients of the cointegrating relationships.

In this case, testing for cointegration entails testing how many linearly independent columns there are in Π, effectively testing for the rank of Matrix Π
(Harris, 1995:78-79). If we solve the eigenvalue specification of Johansen (1991), we obtain estimates of the eigenvalues $\lambda_1 > \ldots > \lambda_r > 0$ and the associated eigenvectors $\beta = (v_1, \ldots v_r)$. The co-integrating rank, r, can be formally tested with two statistics. The first is the maximum eigenvalue test given as:

$$\lambda\text{- max} = -T \ln (1- \lambda_{r+1}), \qquad\qquad (12)$$

Where the appropriate null is r = g cointegrating vectors against the alternative that r $\leq$ g+1. The second statistic is the trace test and is computed as:

$$\lambda\text{-trace} = -T\sum_{i=r+1}^{n} \ln(1 - \lambda i), \qquad\qquad (13)$$

where the null being tested is r = g against the more general alternative r $\leq$ n. The distribution of these tests is a mixture of functional of Brownian motions that are calculated via numerical simulation by Johansen and Juselius (1990) and Osterwald-Lenum (1992). Cheung and Lai (1993) use Monte Carlo methods to investigate the small sample properties of Johansen's λ-max and λ-trace statistics. In general, they find that both the λ-max and-λ trace statistics are sensitive to under parameterization of the lag length although they are not so to over parameterization. They suggest that Akaike Information Criterion (AIC) or Schwarz Bayesian Criterion (SBC) can be useful in determining the correct lag length.

Results and Interpretation
    Unit root test
    Appropriate tests have been developed by Dickey and Fuller (1981) and Phillips and Perron (1988) to test whether a time series has a unit root. Table 1 shows the result the

Augmented Dickey and Fuller (ADF) and the Phillips and Perron (PP) tests with constant only and constant and linear trend.

Table 1: Results of (ADF) and (PP) unit root test

PANEL 1:Levels					
	Constant Only		Constant and Linear Trend		
Variable level	ADF Test	PP	ADF Test	PP	Decision
PRINDEX$_t$	0.449959	0.832181	-2.209335	-2.037736	Non-stationary
NOMINT$_t$	-1.084294	-1.708378	-3.062553	-2.208241	Non-stationary
MONEY2	0.833753	1.789590	-2.851848	-2.376564	Non-stationary
REALINCO	-1.024489	-1.026371	-1.319356	-1.352961	Non-stationary
PANEL 2: First Difference					
ΔPRINDEX$_t$	-3.687092***	-3.519013	-3.771665**	-3.573771**	Stationary
ΔNOMINT$_t$	-3.868959***	-7.767915***	-3.766067**	-7.691303***	Stationary
ΔMONEY2	-4.692160***	-4.573164***	-4.804507***	-4.651870***	Stationary
ΔREALINCO	-6.362819***	-6.349139***	-6.360350***	-6.348650***	Stationary

1% (***), 5% (**)

It worth mentioning here that unit root tests have non-standard and non-normal asymptotic distribution, which are highly affected by the inclusion of deterministic terms e.g. constant, time trend etc. A time trend is considered as an extraneous regressor whose inclusion reduces the power of the test. However if the true data generating process were trend stationary, failing to include a time trend also results in a reduction in power of the test. In addition, this loss of power from excluding a time trend when it should be present is more severe than the reduction in power associated with including a time trend when it is

extraneous (Lopez et al, 2005).So, in this study I have also considered time trend for more robust results.

From Table 1, we find that all the variables seem to be non-stationary at level. However, we can reject the null hypothesis of all variables at first different under the two tests. So, we can conclude that all of them are I (1) - stationary at first different. The above results also imply that the variables would yield spurious results unless the variables are cointegrated.

Johansen Cointegration Test

The Cointegration test performed for the long run relationship among series by using Johansen and Juselius cointegration test. The result of Cointegration Rank Test presented in Table 4 shows cointegration rank of two in trace test and one in max-eigen value test at 5% significance level.

Table 4: Cointegration Rank Test Assuming Linear Deterministic Trend

Null Hypothesis	Alternative Hypothesis	Test Statistics	0.05 Critical Value	Probability Value
		Trace Statistics		
r=0	r=1	80.32147*	63.87610	0.0011
r=1	r=2	44.63108*	42.91525	0.0333
r=2	r=3	24.16963	25.87211	0.0802
r=3	r=4	9.834423	12.51798	0.1349
		Max-Eigen Statistics		
r=0	r>0	35.69039*	32.11832	0.0175
r≤1	r>1	20.46145	25.82321	0.2177
r≤2	r>2	14.33521	19.38704	0.2325

[*]denotes rejection of the null hypothesis at 0.05 level

The results above suggest that levels of the variables entering the price equation are nonstationary but cointegrated. This implies that a long-run stable relationship among the variables exists. This implies that price index, nominal interest rate, money supply and real GDP move together in the long run. This is supported the Quantity Theory of Money (QTM).

Granger Causality Test

Granger's definition of causality is framed in terms of predictability. The basic principle of Granger-causality analysis (Granger, 1969) is to test whether or not lagged values of one variable help to improve the explanation of another variable from its own past. Considering two time series stationary variables Xt and Y_t, according to Granger (1969), Y_t is said to "Granger-cause" X_t (Y→X) if and only if lagged Y_t's help predict and improve X_t. Many tests of causality have been derived and implemented such as Granger (1969), Sims (1972) and Geweke et al. (1982).

The Granger causality test is conducted with 3 lag period and the results are reported in table 5.

Table 5: Result of a Pair-wise Granger Causality Test

Null Hypothesis:	F-Statistic	Prob.	Granger Causality
MONEY2 does not Granger Cause PRINDEX	4.03077	0.0249	Unidirectional Causality
PRINDEX does not Granger Cause MONEY2	0.07272	0.9300	MONEY2→PRINDEX
REALINCO does not Granger Cause PRINDEX	2.98561	0.0611	No Causality
PRINDEX does not Granger Cause REALINCO	0.06099	0.9409	
NOMINT does not Granger Cause PRINDEX	5.96570	0.0052	Unidirectional Causality
PRINDEX does not Granger Cause NOMINT	0.20264	0.8173	NOMINT→PRINDEX
REALINCO does not Granger Cause MONEY2	0.30428	0.7392	No Causality
MONEY2 does not Granger Cause	2.27300	0.1152	

REALINCO			
NOMINT does not Granger Cause MONEY2	0.87289	0.4250	No Causality
MONEY2 does not Granger Cause NOMINT	0.78884	0.4608	
NOMINT does not Granger Cause REALINCO	0.19248	0.8256	No Causality
REALINCO does not Granger Cause NOMINT	1.65810	0.2024	

The Granger causality test shows that there is a unidirectional causality running from M2 money aggregates to inflation and from nominal interest rate to inflation. However, the rests show no causality results. In addition, this study does not provide evidence in supporting the well known fisher effect for Nigeria. Though a long-run relationship exists among the variables, causality does not strictly run from inflation to interest rates as suggested by the Fisher hypothesis, instead a reversed causality between the variables is found.

The top part of Table 6 gives preliminary results of equation (5), using OLS with the HAC or Newey-West standard error that take into account the autocorrelation. We found that the quantity of money has a direct and proportionate effect on the price level i.e the coefficient on MONEY2 is significant and close to 1 (0.983848) whereas, the volume of output has an inverse but non-proportionate effect on the price level i.e the coefficient on REALGDP is -0.422851, its significant but not close to -1 as posit by QTM. On the other hand, the result suggests that the coefficient on MOMRTINTRATE is not significantly different from zero.

Finally, we conducted the Wald coefficient tests to test the joint hypothesis that the quantity of money has a direct and proportionate effect on the price level and the volume of output has a negative and inversely proportionate effect on the price level i.e $\lambda_2=1$ and $\lambda_3 =-1$. The result is presented in four panels. Panel 1 indicates that we should not reject the null hypotheses of $\lambda_2=1$ i.e coefficient of MONEY2 is equal to 1. Panel 2 shows that null hypotheses should be rejected at 5% level of significance i.e the coefficient of REALGDP is not equal to -1. Result in Panel 3 suggests also that null hypotheses should be rejected at 5%

level i.e the coefficient on velocity of money is not equal to 0 while in Panel 4, we conducted a joint hypotheses and it suggests rejection of the null hypotheses.

Table 6: Wald coefficient test for Quantity Theory of Money

Estimated equation; $PRINDEX_t = \lambda_0 + \lambda_1 NOMINT_t + \lambda_2 MONEY2_t + \lambda_3 REALINCO_t + \varepsilon_t$			
Substituted coefficients; PRINDEX = 2.1122941 + 0.041679NOMINT + 0.983448MONEY2 - 0.4222851REALINCO			
PANEL 1: Null Hypothesis; $\lambda_2=1$			
Test Statistics	Value	Df	Probability
t-statistics	-0.297787	46	0.7672
F- statistics	0.088677	(1,46)	0.7672
x^2 – statistics	0.088677	1	0.7659
PANEL 2: Null Hypothesis; $\lambda_3=-1$			
Test Statistics	Value	Df	Probability
t-statistics	8.954418	46	0.0000
F- statistics	80.18161	(1,46)	0.0000
x^2 – statistics	80.18161	1	0.0000

PANEL 3: Null Hypothesis; $\lambda_1 = 0$			
Test Statistics	Value	Df	Probability
t-statistics	2.625834	46	0.0117
F- statistics	6.895006	(1,46)	0.0117
x^2 – statistics	6.895006	1	0.0086
PANEL 4: Null Hypothesis; $\lambda_2 = 1$, $\lambda_3 = -1$			
Test Statistics	Value	Df	Probability
F- statistics	69.71564	(2,46)	0.0000
x^2 – statistics	139.4313	2	0.0000

Summary and Conclusion

The time series on the quantity theory of money based on the ADF and PP unit root tests and the Johansen cointegration techniques show support for the long run relationship among money supply, real income, prices and nominal interest. Applying the Granger causality test, we found a unidirectional causal relationship running from money supply to inflation which provides evidence in support for monetarist's view. In addition, this study does not provide evidence in supporting the well known fisher effect for Nigeria. Even though a long-run relationship exists among the variables (money supply, real income, prices and nominal interest), causality does not strictly run from inflation to interest rates as suggested by the Fisher hypothesis, instead a reversed causality between the variables is found. This paper has also shown that the QTM restrictions on the coefficients of real output and money supply

do not hold in an absolute sense. This conclusion is consistent with the finding of Omanukwue (2010).

Using Nigerian data, this study thus confirms the proposition of quantity theory of money that inflation is a monetary phenomenon. High inflation is driven by rapid money growth, and the relation is essentially one for one. Several recent studies that looked at all the countries on which they could get data on inflation and money growth over long periods found a very high correlation between growth rates of the money supply and of the price level for countries with high inflation rates. These findings support the quantity theory of money, which holds that in the long run the price level moves in proportion with changes in the money supply, at least for high-inflation countries.

Policy implication: The Central Bank of Nigeria (CBN) who is responsible for the design and conduct of monetary policy in Nigeria should adopted inflation as its central target variable of its monetary policy in order to achieve macroeconomic objective of price stability.

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