The Quantity Theory of Money: Evidence from Nigeria

Phebian N. Omanukwue[*]

This paper examines the modern quantity theory of money using quarterly time series data from Nigeria for the period 1990:1-2008:4. The study uses 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 finds convincing evidence of a long-run relationship in line with the quantity theory of money. Restrictions imposed by the quantity theory of money on real output and money supply do not hold in an absolute sense. The granger causality is also used to examine the causality between money and prices. The study establishes the existence of 'weakening' uni-directional causality from money supply to core consumer prices in Nigeria. In all, the result indicates that monetary aggregates still contain significant, albeit weakening, information about developments in core prices in Nigeria. The paper finds that inflationary pressures are dampened by improvements in real output and financial sector development.

I.   Introduction

Money plays an important role in facilitating business transactions in a modern economy. The second round effects of these on the overall growth and development of the economy is the point where monetary and fiscal policies play their roles. Conceptually, the quantum of money in the economy and its consistency with the absorptive capacity of the economy underpins the essence of monetary policy. In Nigeria, the Central Bank of Nigeria (CBN) is responsible for the design and conduct of monetary policy. Over the years, the CBN has adopted a wide range of monetary policy frameworks such as 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.

In recent times, there have been plans to transit to an inflation targeting framework as the stable relationship assumed under the quantity theory of money

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between money and prices captured by the velocity of money may no longer exist (Smith, 2002; Benbouziane and Benamar, 2004). This paper is motivated by the need to establish empirically the validity or otherwise of the quantity theory of money in Nigeria.   This is especially important as a clearer picture of this relationship will aid the Central Bank of Nigeria in its quest for the most reliable and effective monetary policy framework.

Following this introduction, section II reviews briefly the literature on the subject. Section III discusses the methodology for the study. In section IV, analysis of the results and findings are discussed, while section V concludes the paper.

II.   Review of existing works

The quantity theory of Money (QTM) has its roots in the 16th century during which classical economists such as Jean Boldin at that time sought to know the cause of the increases in French prices. He concluded that, among other factors, increases in gold and silver which served as currencies were responsible for the rise in the demand for French-made goods and, hence, French prices, thus linking movements in prices to movements in money stock. By the 1690s, the quantity theory was further advanced by John Locke to examine the effects of money on trade, the role of interest rate and demand for money in the economy. In particular, the role of money as a medium of exchange to facilitate trade transactions was born. Economists at the time inferred that the quantum of money needed for such transactions would depend on the velocity of money in circulation and the relationship between the demand and supply of money such that where there was excess demand over supply interest rates rose and vice versa (Cantillon, 1755; Locke 1692 as cited in Ajuzie, et al, 2008).

Modern classical economics school of thought, which has come to be known as the monetarists, continues in the same light as the early economists and is often concerned with explanations for changes in price level. To them, a stable and equilibrating relation exists between the adjustments in the quantity of money and the price level. The more orthodox monetarist assumes that a rise in the quantum or variation in money supply determines the value of money, but not necessarily changes in output. In other words, they refute any form of monetary influence on real output both in the short-and long-run. This led to the popular paradigm that, "Inflation is always and everywhere a monetary phenomenon". For the less stringent monetarist, they agree that money influences output in the short-run, but only prices in the long-run. Nevertheless, irrespective of the path of adjustment, the monetarist all seem to concur that in order to reduce or curtail

inflationary growth, money growth should be less than or equal to the growth in output.

The quantity theory of money is hinged on the Irvin Fisher equation of exchange that states that the quantum of money multiplied by the velocity of money is equal to the price level multiplied by the amount of goods sold. It is often replicated as MV= PQ, M is defined as the quantity of money, V is the velocity of money (the number of times in a year that a currency goes around to generate a currency worth of income), P represents the price level and Q is the quantity of real goods sold (real output). By definition, this equation is true. It becomes a theory based on the assumptions surrounding it.

The first assumption is that velocity of money is constant. This is because the factors, often technical, habitual and institutional, that would necessitate a faster movement in the velocity of money evolve slowly. Such factors include population density, mode of payment (weekly, monthly), availability of credit sources and nearness of stores to individuals. This assumption presupposes that the velocity of money is somewhat independent of changes in the stock of money or price level. However, the Keynes liquidity preference theory suggests that the speculative components of money demand affect money velocity. Friedman in his modern theory of the quantity theory of money further explores the variables that could affect the velocity of money to include human/non-human wealth, interest rate, and expected inflation.

The second assumption guiding the QTM is that factors affecting real output are exogenous to the quantity theory itself. In other words, monetary factors do not influence developments in the realeconomy. The third assumption states that causality runs from money to prices. Thus, the quantity theory of money can be represented as

$$M\overline{V} \rightarrow P\overline{Q}$$

In simple terms, this states that prices vary proportionally in response to changes in the quantum of money, with velocity and real output invariant.

The QTM is, however, fraught with some weaknesses. First, is its non-recognition of money as a resource that could spur production. It thus does not explain recessions or unemployment since it assumes away adjustment problems. Secondly, critics have also observed that changes in the quantum of money in

circulation are the effects of variation in business cycle, rather than the cause as opined by the monetarists.

Some of the earlier works conducting an empirical testing of the quantity theory of money include those of Friedman and Schwartz (1982), Sims (1972), Bhattacharya (1972), and Brahmananda (1977). Sims (1972) introduced the concept of Granger causality into the testing procedure. In his study, Bhattacharya (1972) specified a linear regression model to examine the relative performance of reduced form versions of the basic Keynesian model and the Quantity Theory model. He concluded that the Keynesian model explains monetized income better than the QTM. Brahmananda (1977) employing single equation econometric methods investigated the link between real national income and price level in India. He reached the conclusion that the QTM explains the developments in the price level.

Modern research on the QTM such as that of Ahmed (2003) which adopted a block causality test showed that there was a unidirectional causality from output and prices to money. That is, interest rate and money as a block do not cause output and prices, but output and price cause interest rate and money. Miyao (1996) used quarterly data for the period 1959 to 1993 to investigate the long-run relationship between money, price level, output, and interest rates in the United States and found that there was mixed evidence of a long-run relationship prior to 1990 and little or no evidence of a long-run cointegration relationship for the entire sample. A similar study by Emerson (2006) to examine the long-run relationship between money, prices, output, and interest rates in the United States using quarterly data for the period 1959 to 2004 reached the conclusion that a long-run relationship exists.

Few studies such as Anorou (2002) and Nwaobi (2002) examined such relationship in the Nigerian context. Anoruo (2002) adopted the Johansen and Juselius co-integration method to establish the stability of broad money demand function in Nigeria during the structural adjustment program period. His result suggests that a long run relationship existed between M2, and real discount rate and economic activity concluding that money was a viable monetary policy instrument to stimulate economic activity in Nigeria. A similar research by Nwaobi (2002) using data from 1960-95, established that money supply, real GDP, inflation, and interest rate were cointegrated in the Nigerian case.

This paper expands upon these by using quarterly data devoid of rigidities of the monetary control era that characterized the Nigerian economy prior to the 90s.

Furthermore, the paper in line with anecdotal evidences makes an apriori assumption that the velocity of money is not constant. Thus, the paper assumes that relative to the past, the financial sector has evolved and, thus, introduces a measure of financial sector development in the quantity theory of money analysis.

III.   Data, Specification and Methodology
III.1   Data
This paper employs quarterly data for the period 1990-2009 obtained from the CBN Statistical Bulletin (various issues). This is to ensure that the long–run cointegrating relationship can be estimated as well as ensure that information that would otherwise be lost when using annual data is captured.

Quarterly data on consumer prices (cpi), money supply (nm), interest rate proxied by maximum lending rate (mlr), and real output (ry) were used. The measure of money supply used is the broad definition of money supply since it reflects the underlying changes in the Nigerian monetary sector, capturing transactions and speculative needs in the form of time and other forms of deposits. Financial sector development is proxied by the ratio of demand deposits to time deposits. The measure of prices considered is the core consumer prices. This is chosen as changes in non-core (food) prices are often not attributed to monetary developments. All variables, except for rates/ratios are in their natural logarithm form.

III.2   Model specification
Drawing from the works of Emerson (2006) and Akhtaruzzaman (2008), the quantity theory of money identity is written as

$$p_t + y_t \equiv m_t + v_t \tag{1}$$

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

The modern QTM does not assume that the velocity of money is constant. Therefore, this paper assumes that financial and institutional structures have evolved over the years and specifies the velocity of money as a function of the nominal interest rate (mlr), real income (ry), inflation (inf), ratio of demand deposits to time deposits (dtd) (proxy for financial development).

$$v_t = \beta_0 + \beta_1 mlr + \beta_2 ry + \beta_3 \inf + \beta_4 dtd + \mu_t \tag{2}$$

where $\beta_0, \beta_1, \beta_2, \beta_3, \beta_4$ are coefficients and μ_t is a random error.

Combining (1) and (2)

$$p_t = m_t + \beta_o + \beta_1 mlr + \beta_2 ry + \beta_3 \inf + \beta_4 dtd + \mu_t - y_t \qquad (3)$$

Taking into consideration like terms and not making assumptions about the exogeneity of output and money supply, the following model is estimated:

$$p_t = \beta_o + \beta_1 mlr + \beta_2 ry + \beta_3 dtd + \beta_4 m_t + \mu_t \qquad (4)$$

This study differs from known studies in Nigeria in a number of ways. First, it uses recent and quarterly data. Second, unlike other known studies for Nigeria, it introduces a measure of financial development in the quantity theory of money analysis. Third, as opposed to the Johansen co-integration technique, it uses the Engle-Granger two-stage test for co-integration analysis.

III.3   Methodology

An initial analysis of the causal relationship, using the granger-causality test is conducted to assess the direction of causality among the variables. The Granger causality test states that a stationary variable x is said to granger-cause a stationary variable y only if y is predicted better by using the past changes of x, together with the past changes of y itself, rather than by using only the past changes of y. A bi-variate autoregressive standard Granger causality model is presented below:

$$\Delta Y_t = \alpha + \sum \alpha Y_i \Delta Y_{t-i} + \sum \alpha X_i \Delta X_{t-i} + \mu_t \qquad (5)$$

Where Δ is the first-difference operator and ΔX and ΔY are difference stationary time series. In order to specify a non-spurious and appropriate model for empirical investigation, the time series properties of the variables are identified using the unit root test, which is conducted using the Augmented Dickey-Fuller (ADF)[1] .

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[1] The ADF test is an iterative process that starts by testing the null hypothesis that the variable(s) in their level form are non-stationary that is integrated of an order of one, I (1). The rejection of the null hypothesis indicates that the variables are stationary; while non-rejection of the null hypothesis indicates they are non-stationary and would need to be differenced and subjected to further testing that the differenced series are non-stationary, that is I(1) . 0).

Fig 1: Visual Plots of Data in Logarithm

LOG(CCPI)

LOG(RY)

DTD

Maximum Lending Rate

LOG(NM)
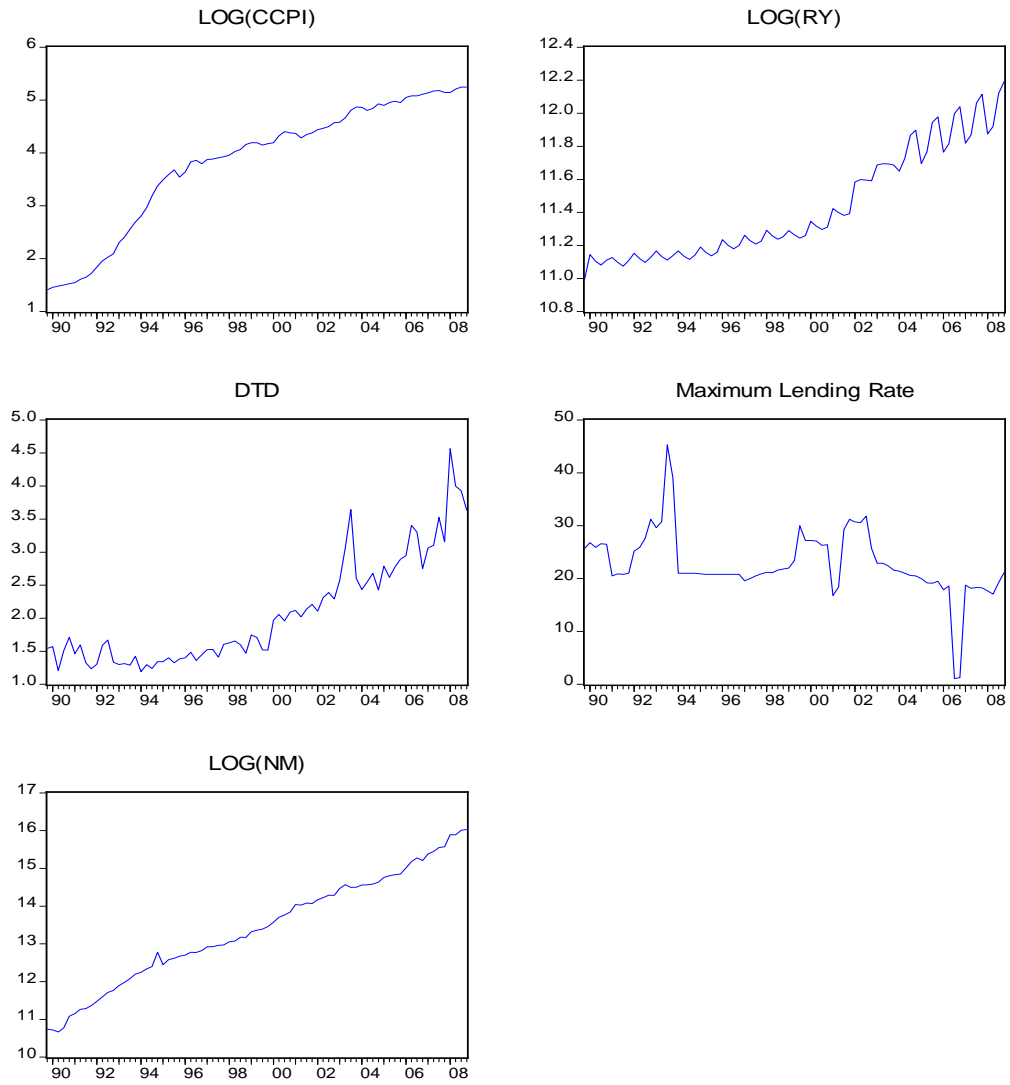
Fig 2: Visual plots of stationary variables
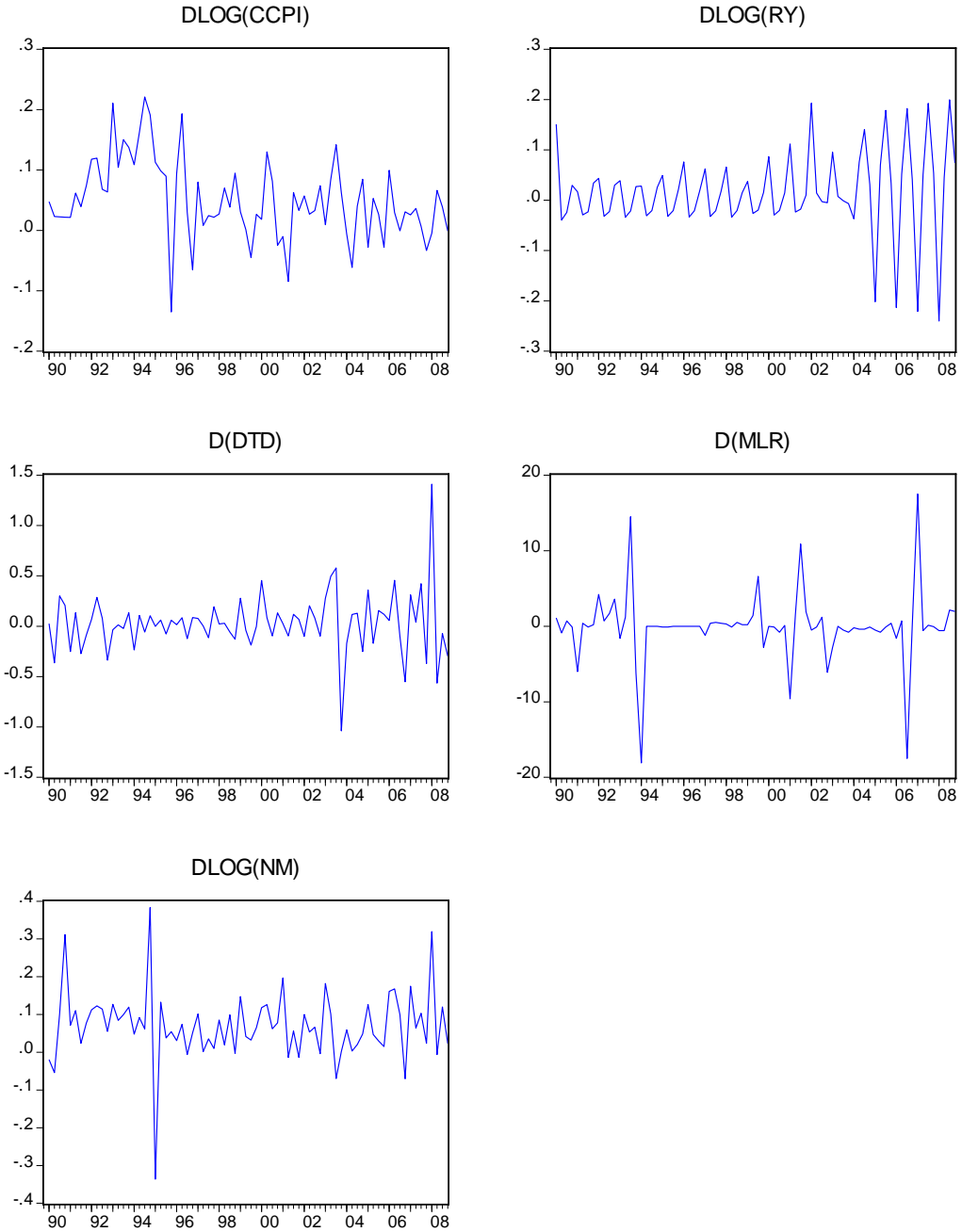
From the visual plots of the variables with the exception of lending rate, the appropriate test equation is that with a constant and a trend as the series appear to be wandering around a linear trend. The plot of the lending rate appears to be wandering around a non-zero mean and thus the test equation with a constant term is applied. The result of this test is presented in table 1.

Table 1: Augmented Dickey Fuller Test (Null Hypothesis: Has a Unit Root)

ADF Regression with Drift					
Series in log levels	**t-stat**	**1%**	**5%**	**10%**	**log (At) ~ I(X)**
Nominal Money (nm)	-0.57	-3.51	-2.90	-2.58	I (1)
Core CPI (ccpi)	-3.29	-3.51	-2.90	-2.58	I (0)
Real Output (ry)	0.82	-3.51	-2.90	-2.58	I (2)
DD/TD (dtd)	1.11	-3.51	-2.90	-2.58	I (1)
Mlr	-2.57	-3.51	-2.90	-2.58	I (1)

ADF Regression with Drift and Trend					
Series in log levels	**t-stat**	**1%**	**5%**	**10%**	**log(At) ~ I(X)**
Nominal Money (nm)	-2.32	-4.08	-3.47	-3.16	I (1)
Core CPI (ccpi)	-0.62	-4.08	-3.47	-3.16	I (1)
Real Output (ry)	-1.92	-4.08	-3.47	-3.16	I (2)
DD/TD (dtd)	-3.81	-4.08	-3.47	-3.16	I (0)
Mlr	-2.95	-4.08	-3.47	-3.16	I (1)

The Augmented-Dickey Fuller tests suggest that nm, ccpi, mlr and dtd are integrated of order one, I(1), while ry is integrated of order 2, I(2). Though the Phillips Peron test are not presented in this study , the test using the Bartlett Kernel with automatic Newey-West bandwith selection, however, suggests that all variables can be treated as I (1) processes.

IV.   Result
Granger-Causality Test

The results from the granger causality tests show that changes in broad money supply granger causes the core consumer price index (Table 2). Thus, the paper finds evidence that core prices are better predicted by past values of changes in broad money stock and past changes of prices itself. This is expected since monetary developments are expected to affect demand driven prices reflected in the core CPI.

Table 2: Pair-wise Granger Causality Test

Lags: 4

Null Hypothesis:	Obs	F-Statistic	Prob.
DLOG(CCPI) does not Granger Cause DLOG(NM)	72	0.09360	0.9841
DLOG(NM) does not Granger Cause DLOG(CCPI)		2.10597	0.0905

From the pair-wise tests, it can be deduced that the null hypothesis is rejected at the 10 percent level of significance.

Long-Run Static Model

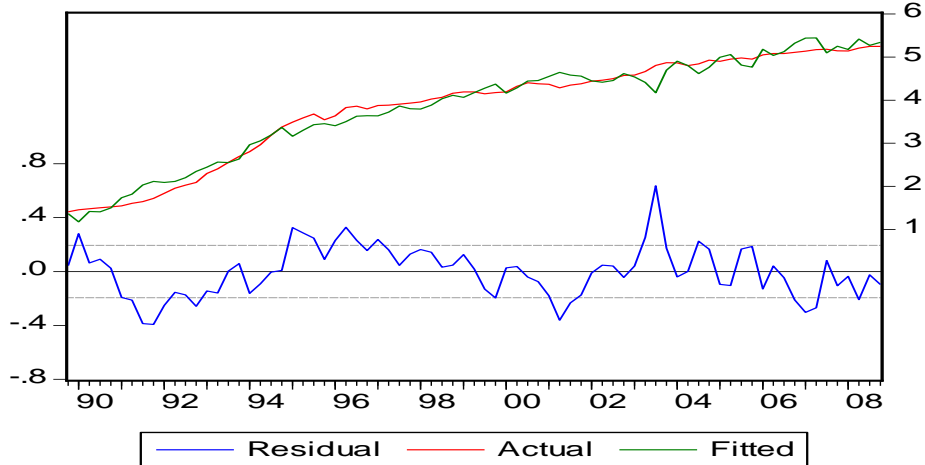Estimated results from equation 4 is found in table 3 below

Table 3: Long-Run (Static) Equation
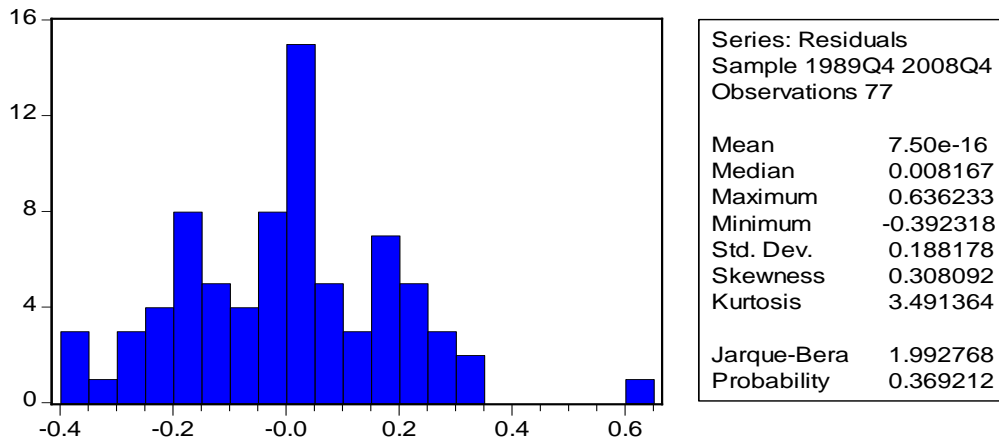
Dependent Variable: LOG(CCPI)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	11.14775	3.616207	3.082719	0.0029
LOG(RY)	-1.343890	0.248314	-5.412063	0.0000
DTD	-0.443356	0.071325	-6.215964	0.0000
MLR	-0.010494	0.004135	-2.537643	0.0134
LOG(NM)	0.553826	0.155628	3.558659	0.0007
@TREND	0.046506	0.011263	4.129099	0.0001
R-squared	0.975263	Durbin-Watson stat		0.671567
Adjusted R-squared	0.973521	Akaike info criterion		-0.360090
S.E. of regression	0.194691	Schwarz criterion		-0.177456

Diagnostics of the Long-Run Equation
Figure 1: Actual, Fitted and Residual Plot of the Long-Run Equation

Figure 2: Histogram Normality Test for Residuals of the Long-Run Equation

Series: Residuals	
Sample 1989Q4 2008Q4	
Observations 77	
Mean	7.50e-16
Median	0.008167
Maximum	0.636233
Minimum	-0.392318
Std. Dev.	0.188178
Skewness	0.308092
Kurtosis	3.491364
Jarque-Bera	1.992768
Probability	0.369212

From the histogram, the test for normality of the residuals shows that they are normally distributed. From table 3, the long-run equation indicates a good fit shown by the high coefficient of determination and the residual graph, but a very low Durbin – Watson statistics indicative of positive autocorrelation. Further tests using the LM test confirms that the null hypothesis of no autocorrelation is rejected. The high coefficient of determination may give a wrong indication of the presence of a long-run equilibrium relationship. Consequently, the paper goes further to test for unit root in the residuals of the long-run regression.

A co-integration test using the Augmented Dicker Fuller test procedure was conducted on the residuals from the estimated long-run equation in Table 3. In table 4 below, the tau statistics of -3.82 is less than the critical value of -3.47 and -3.16 at the 5 and 10 per cent levels of significance. Thus, the null hypothesis that the least squares residuals contain a unit root is rejected. This implies that there is a long-run co-integrating relationship among the variables, core consumer prices, lending rates, broad money, financial sector development and real output.

Table 4: Augmented Dickey Fuller Test for Residuals
(Null Hypothesis: Has a Unit Root)

Exogenous: Constant

Lag Length: 0 (Automatic based on SIC, MAXLAG=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.852513	0.003704
Test critical values:	1% level	-3.51	
	5% level	-2.90	
	10% level	-2.58	

Thus, the co-integrating regression is as follows:

$$\log(ccpi) = 11.15 - 1.34\log(ry) - 0.44dtd - 0.01mlr + 0.55\log(nm) + 0.05t \qquad (6)$$

The long-run co-integrating regression in equation 6 suggests that real output, financial sector development, interest rate and money supply all have significant influence on the level of consumer prices in Nigeria. All variables , have the correct signs. Trend has a significant positive effect on core prices. A unit increase in real output reduces consumer prices by more than one unit. This implies a unit increase in real output will lower core consumer prices by 1.34 units in the same quarter. This conforms to the quantity theory that states that the coefficient of real output should be less than one since more goods and services in the hands of the public means consumers can enjoy lower prices.

The results also suggest that as transactions in the financial sector become efficient with improved payment system, use/availability of money substitutes, and technological progress, prices of core consumer goods should be lower. The results indicate that a unit increase in financial sector development variable leads

to a decline of 0.44 units in consumer prices. In conformity with the results in Mordi, et al (2007), interest rates, proxied by lending rates are significant ininfluencing consumer prices, but quite marginally. It meets apriori expectations, as one would expect increases in lending rates to exert a dampening effect on demand driven prices. Prices respond significantly to monetary developments. A unit increase in the quantum of money supply increases consumer prices by 0.55 units within the quarter. This is in conformity with the quantity theory that states that the coefficient of money should be significant. The results do not, however, conform with a close one to one relationship between money supply and consumer prices as opined by the theory. The results herein conform to the results reached in Mordi, et al (2007). In their long run model, it was shown that for every unit increase in money supply, core prices increased by 0.42 units. Of all the variables, real output, money supply and financial sector development exert the highest impact on consumer prices. The results provide evidence that monetary aggregates still contain highly significant and useful information about developments in prices, which may lead to the conclusion that inflation is a monetary phenomenon, even though the relationship may be weakening. However, the results tell us that positive developments in the real and financial sector can dampen continuous increase in core consumer prices. Indeed, real sector developments, rather than monetary developments exert the highest impact in reducing core consumer prices. This may be an evidence of a 'weakening' relationship between monetary aggregate and prices as one considers the non-proportionality between broad money and prices in equation 6, which seems to further validate the granger causality test, when conducted with a 'strict' level of significance.

IV.1.   Testing the Implications of the Quantity Theory

After deriving the co-integrating parameters in Table 3, the paper conducts an empirical test on the joint hypothesis that coefficient of output (β_2) = -1 and coefficient of money (β_4) = 1, in order to ascertain the implications of the quantity theory from equation 4. The results is shown below

Table 5: Wald Test

Test Statistic	Value	df	Probability
F-statistic	4.238048	(2, 71)	0.0183
Chi-square	8.476095	2	0.0144

Null Hypothesis Summary:

Normalized Restriction (= 0)	Value	Std. Err.
1 + C(2)	-0.343890	0.248314
-1 + C(5)	-0.446174	0.155628

Restrictions are linear in coefficients.

The Wald test results show that the null hypothesis is rejected at all acceptable levels of significance. This suggests that the restrictions imposed by the QTM do not hold for the sample period. However, this does not negate that the parameters on real output and money supply are close to the values predicted by the quantity theory of money.

V.   Conclusion

Within the context of the issues highlighted at the introduction of the study, this paper has established that there exists a long-run relationship among money, interest rate, prices and financial sector development in Nigeria for the sample period 1990-2008. The paper has shown that the QTM restrictions on the coefficients of real output and money supply do not hold in a strict sense. The empirical results suggest that monetary aggregate still contain significant information about core consumer prices, but a weakening relationship between money supply and prices as evidenced by the granger causality test on core consumer prices. The study reveals a direct and positive relationship between money and prices, but a non-proportional relationship between the two variables as prices increase by just a little above half when there is a unit increase in money supply, which may also suggest a 'thinning' out relationship. Further independent studies will need to be conducted to confirm this, as this may portray a threat to monetary policy in Nigeria relying only on the use of monetary aggregates as an intermediate target to affect prices. Perhaps, if the measure of monetary aggregate used is re-examined and sub-sample analysis conducted, more information may be gleaned.

An interesting aspect is the role of real output and financial sector development in influencing core consumer prices. The real output level impacts greatly and significantly on core prices in the long- run. This implies that policies targeted at core prices may be better tracked by developments in real output than by monetary aggregates in the long-run. It further indicates that inflation in Nigeria may not be entirely a monetary phenomenon. Thus, policy framework/designs should be re-evaluated and perhaps consider impacting on core prices via variables that affect real output and financial sector variables. Current efforts at developing the financial sector should be sustained as results from the study indicate that it dampens the weight of inflationary pressures on policy formulations.

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