

On the Adequacy Model for the Relationship Between Commodity Terms of Trade and Money Supply in Nigeria

Zebulun Gladys ThankGod¹, Biu O. Emmanuel² and Ogolo Ibinabo Magnus³

¹Department of Mathematics and Statistics, Ignatius Ajuru University of Education, Port Harcourt, Rivers State, Nigeria. ²Department of Mathematics and Statistics, University of Port Harcourt, Rivers State, Nigeria.

³School of Foundation Studies, Rivers State College of Health Science and Management Technology, Rumueme, Port Harcourt, Nigeria.

Corresponding author: ibinabo101@yahoo.com

Abstract

This research determined an adequate model for the relationship between commodity terms of trade and money supply in Nigeria. The Kwiatkowski Phillips-Schmidt-Shin (KPSS) unit root test was used to establish whether the commodity terms of trade variables for the three sets of data were stationary. Three models were built based on commodity terms of trade' stationarity. The first Model is the actual series before transformation. The second Model is the log model and the third model is the square root model. All models contained the variables, Live Animals, Vegetable Products, Prepared Foodstuffs & Beverages, Mineral Products, Chemical & Allied Industries Products, Plastic and Rubber and Cement Products, Leather Products, Wood Products, Paper Making Material Products, Textiles Products, Footwears & Headgears, Ceramics products, Precious Metals Products, Machinery and Chemical Appliances, Vehicles & Parts Products, Base Metals and Miscellaneous Manufactured Articles. The ordinary least square method was used to estimate the parameters and the actual model has six (6) significant parameters, $R^2 = 99.1\%$, AIC = 347.66, BIC = 350.96 and DW = 1.60, the square root model has twelve (12) significant parameters, $R^2 = 99.6\%$, AIC = 116.40, BIC = 119.90 and DW = 2.496, and the log model has one (1) significant parameter, $R^2 = 99.9\%$, AIC = 25.57, BIC = 28.87 and DW = 2.07. The result showed that the square root model which has the highest significant parameters, (x_1 - Live Animals, x_2 - Vegetable Products, x_3 - Prepared Foodstuffs & Beverages, x_5 - Chemical & Allied Industries Products, x_6 - Plastic and Rubber and Cement Products, x_7 - Leather Products, x_8 - Wood Products, x_{10} - Textiles Products, x_{13} - Precious Metals Products, x_{16} - Vehicles & Parts Products, and x_{17} - Miscellaneous Manufactured Articles), is the adequate model for identifying the relationship between money supply (MS) and commodity terms of trade (CTOT) since its independent variables have more significant parameters at 1%, 5% and 10% levels. This result contradicts the more works carried out using only logarithm transformations when the variables are large values. It was recommended that more detailed work be carried out using other transformation techniques (i.e another power transformation techniques) to identify a more suitable model to be used for the study or prediction of the variables.

Keywords: Commodity, Trade, Money Supply, Model, Adequacy.

Introduction

The study on commodity terms of trade has renewed steam in recent years. From the early 2000s to the commencement of the present financial crisis, many developing countries saw strong growth, which corresponded with a steep rise in commodity prices. Commodity prices have been in general decline for several decades prior to the turn of the twenty-first century. Commodity prices surged by roughly 75% in real terms on average between mid-2008 and mid-2009. By historical standards, the

most recent commodity boom was broad-based and long-lasting, with most commodity prices growing rapidly (especially energy and industrial inputs, including agricultural raw materials and metals, but also major food crops and some beverages). Commodity prices fell sharply after the financial crisis, and they have remained extremely unpredictable since then. As the global economy improves, it will be interesting to see how much strong commodity price pressures resurface.

Unfortunately, current commodities boom assessments typically rely on unreliable pricing data, such as a country's aggregate terms of trade or the price of one or two important commodity exports.

Over time, there has been much discussion on the relationship between commodity terms of trade and money supply. Nigeria, as a developing country, is beset by massive debt, structural imbalances, and unpredictability. The factors of money supply as they relate to commodity terms of trade have been discovered. The majority of economists believe that the problem of Nigeria's economic growth, and hence the money supply, has been poorly recognized and controlled. Increase in the money supply, for example, will increase the quantity of money held by individuals and businesses, causing them to spend more. As a result, total demand will rise. When the money supply is reduced, the opposite is true. That is, a reduction in the money supply will result in a reduction in the amount of money held by individuals and businesses, causing them to spend less. As a result, aggregate demand will fall.

Time series modeling entails gathering and analyzing historical data or previous observations of a time series in order to construct a suitable model that represents the series' underlying structure. This model is then used to forecast future values for the series. As a result, time series forecasting can be defined as the process of predicting the future by studying the past. Over the last few decades, time series modeling has drawn the attention of a large number of researchers (Sarkar, 1986). The study looked for the best model to employ when determining the relationship between commodity terms of trade and money supply.

Statement of the Problem

Over time, there has been much discussion on the relationship between commodity terms of trade and money supply. The goal of this research is to dispel the notion that the money supply is self-contained. Nigeria, as a developing country/economy, is beset by substantial debt, structural imbalances, and unpredictability. It's become important to understand the factors that influence money supply as they relate to commodity terms of trade. The majority of economists believe that the problem of Nigeria's economic growth, and hence the money supply, has been poorly recognized and controlled. Increases in the money supply, for example, will increase the quantity of money held by individuals and businesses, causing them to spend more. As a result, total demand will rise. When the money supply is reduced, the opposite is true. That is, a reduction in the money supply will result in a reduction in the amount of money held by individuals and businesses, causing them to spend less. As a result, aggregate demand will fall. This study looks into the relationship and causality between money supply and commodity terms of trade to discover whether there are any specific commodities that affect/increase/decrease money supply. Identifying trends, patterns, and linkages, as well as accurately predicting events, occurrences, and impact, is at the forefront of every data analyst's or statistician's mind. This study looked at the factors that influence Nigeria's economic growth as well as the direction of causality between the economy's money supply and key variables known as commodity terms of trade.

Aim and Objectives of the Study

The aim of this study is to determine an adequate model for the relationship between commodity terms of trade and money supply in Nigeria from the year 2000 to 2019. The objectives of the study are:

1. To transform the data sets into logarithm and square root transformation.
2. To test for stationarity of the independent variables of the three data sets hence build models based on the stationarity.
3. To estimate the parameters of the three models considered and compare them using model selection criteria, R^2 and the number significant parameters to identify the adequate model for the study.

Definition of Terms

Model: A model is an abstraction of reality.

Specification: It is also known as model identification, and is an informal process which involves plotting, preliminary data analysis, and intuitive sensing about the fundamental elements of the system to be modelled.

Unit root test: It is a statistical hypothesis test of stationarity that is designed for determining whether differencing is required.

Transformation: the replacement of the variables in an algebraic expression by their values in terms of another set of variables.

CTOT: Commodity terms of trade.

Reviewed Works on Commodity Terms of Trade and Money Supply

Terms of trade (TOT) are the ratio between a country's export prices and its import prices. According to Spatafora & Tytell (2009), terms-of-trade is the ratio of commodity export prices to commodity import prices, with each price weighted by the share of the relevant commodity in the country's total trade. The ratio is calculated by dividing the price of the exports by the price of the imports and multiplying the result by 100. It can be also be interpreted as the amount of import goods an economy can purchase per unit of export goods (Bloch and Sapsford 1998). That is:

$$TOT = \frac{\text{EXPORT PRICE INDEX}}{\text{IMPORT PRICE INDEX}} \times 100 \quad (2.1)$$

When a country's TOT is less than 100 percent, it is importing more than it is exporting, and when the figure is larger than 100 percent, it is exporting more than it is importing, according to Equation (2.1). For example, if the index of export prices raises 10% and the index of import prices climbs 5% over a particular period, the terms of trade are:

$$TOT = \frac{110}{105} \times 100 = 104.8 \quad (2.2)$$

This means that the terms of trade have improved by 4.8%.

When the terms of trade rise above 100 they are said to be improving and when they fall below 100, they are said to be worsening.

Commodity terms of trade refer to the terms of trade for commodities only, excluding services. The commodity terms-of-trade (CTOT) index is different from traditional terms of trade in that it only looks at commodities in a country's trading system.

A model is a depiction of a real-world process that has been simplified. It should be representational in the sense that it should include the most important aspects of the phenomenon being

investigated. One of the goals of modeling is to create a simple model that can describe a complicated occurrence.

Biu *et.al* (2021) in the study "Commodity Terms of Trade and Their Effects on Money Supply in Nigeria" pretested the commodity terms of trade for stationarity using the KPSS test. After confirming that they were stationary, co-integration between money supply and commodity terms of trade was done. The results indicated co-integration and significant relationship between mineral products, precious metals and Money Supply. The results also indicated cointegration and significant relationship between animal products, plastic and rubber, paper making material products and Money Supply. They concluded that these results showed that there exists a relationship between money supply and mineral products, precious metals, animal products, plastic and rubber and paper making material products, since their parameters were significant at 1%, 5% and 10% levels.

Akpanta and Iwueze (2009) demonstrated how to use the Bartlett (1947) transformation technique on time series data without taking into account the model structure. They demonstrated Bartlett's transformation for time series data, which involves regressing the logarithms of group standard deviations against the natural logarithms of group averages and determining the slope (β) of the connection, which is known as power transformation.

$$X_t = \begin{cases} \log Y_t, \beta = 1 \\ Y_t^{(1-\beta)}, \beta \neq 1 \end{cases} \quad (2.3a)$$

$$(2.3b)$$

Where Y_t is the value of the original series at time t , to be transformed.

They concluded that it is better to use the estimated value of Slope(β) directly in the power transformation.

Table 2.1; Bartlett's Transformation

(β) value	0	$\frac{1}{2}$	1	$\frac{3}{2}$	2	3	4
Transformation	No Transformation	$\sqrt{y}$	$\text{Log}_e Y_t$	$1/\sqrt{y}$	$1/y$	$1/y^2$	y^2

Sources: Author's Work (2022)

Materials and Method

This study was limited to the average yearly commodity terms of trade and money supply in Nigeria covering the period 2002 to 2021. The data was collected from central bank of Nigeria (CBN) and National Bureau of Statistics Bulletin, average monthly commodity terms of trade converted to average yearly by adding the total number per year and dividing each by 12 and average yearly data for money supply in Nigeria covering the period 2002 to 2021 (see *appendix*). The data sets were transformed to log data and square root data which were used to obtain the log model and square root model. The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root test and the Ordinary Least Square method were used to analyze the data.

Model specification

The mean, variance, and autocorrelation structure of stationary data remain constant over time. The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) unit root test was used to determine stationarity. The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test figures out if a time series is stationary around a mean or linear trend, or is non-stationary due to a unit root [Phillips, (1987); Phillips and Perron, (1988); Phillips and Xiao (1998)].

Therefore, the hypothesis below was tested:

H₀: The time series generated by the data is stationary

H₁: The time series generated by the data is not stationary

The time series model to be considered is:

1. The actual model:

$$Y_t = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \dots + \beta_k X_k + e_i \quad (3.1)$$

However, the models after transformation are

2. Log model:

$$\ln Y_t = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \dots + \beta_k \ln X_k \quad (3.2)$$

3. Square root model:

$$\sqrt{Y_t} = \beta_0 + \beta_1 \sqrt{X_1} + \beta_2 \sqrt{X_2} + \beta_3 \sqrt{X_3} + \beta_4 \sqrt{X_4} + \beta_5 \sqrt{X_5} + \dots + \beta_k \sqrt{X_k} \quad (3.3)$$

Where

$t = 1 \dots n$

Y_t is money supply; the dependent variable, endogenous variable.

$X_1 + X_2 + \dots + X_k$ are commodity terms of trade the independent variables, explanatory variables ($k=17$)

$\beta_0, \beta_1, \dots, \beta_k$ are coefficients of the independent variable effect on the dependent variable.

e_i is the Error term.

n is the sample size and k is the number of independent variables ($p=17$)

Model Selection Criteria

The model selection criterion is used to find the right function. The best model is the one that minimizes the criterion. In recent years, numerous criteria for selecting among models have been developed, including residual sum of squares (ESS) multiplied by a penalty component based on the model's complexity. The following are some of these criteria:

Akaike Information Criteria (AIC)

Akaike (1974) also developed another procedure which is known as Akaike information criteria. The form of this statistic is given below:

$$AIC = \left(\frac{ESS}{T} \right) e^{\left(\frac{2k}{T} \right)} \quad (3.4)$$

The value of AIC decreases when some variables are dropped (Ramanathan, 1995).

Hunnan and Quinn (HQ) criterion

Hunnan and Quinn (1979) developed a procedure which is known as HQ criteria. Statistic of the procedure can be represented as:

$$HQ = \left(\frac{ESS}{T} \right) \left(\ln T \right)^{\left(\frac{2K}{T} \right)} \quad (3.5)$$

The value of HQ will decrease provided there are at least 16 observations (Ramanathan, 1995)

SCHWARZ Criterion

Craven and Wahba (1978) developed a procedure which is known as SCHWARZ (BIC) Criteria. The form of this procedure is represented as:

$$SCHWARZ = \left(\frac{ESS}{T} \right)^T_{K/T} \quad (3.6)$$

The value of SCHWARZ will also decrease provided there are at least 8 observations (Ramanathan, 1995).

Results

According to Time Series Modeling, unit root is necessary to determine whether the time series is stationary or non-stationary and, if not, how many times the variables must be differenced to achieve stationarity. The stationarity of the series were determined using the KPSS unit root test with the help of Gretl Statistical software. Then, the KPSS results were summarized in Table 4.1 - 4.3, Table 4.4 shows the three models parameter estimates with their model selection criteria and R-square using the Ordinary Least Square Method.

Table 4.1: KPSS Test on the Commodity Terms of Trade (independent)

Variable (Commodity Terms of Trade) Statistics	Test Statistic (without trend)	P-Value	Stationary
Live animals, animal products	0.2887	1.0000	Yes
Vegetable products	0.1121	1.0000	Yes
Prepared foodstuffs, beverages, spirits and vinegar, tobacco	0.1404	1.0000	Yes
Mineral products	0.3351	1.0000	Yes
Products of the chemical and allied industries	0.1492	1.0000	Yes
Plastic, rubber and articles thereof	0.2648	1.0000	Yes
Raw hides and skins, leather, furskins, saddlery, etc.	0.2259	1.0000	Yes
Wood and articles of wood, wood charcoal and articles	0.3521	1.0000	Yes
Paper making material, paper and paperboard, articles	0.1123	1.0000	Yes
Textiles and textile articles	0.1642	1.0000	Yes
Footwear, headgear, umbrellas, sunshades, whips, etc.	0.2764	1.0000	Yes
Articles of stone, plaster, cement, asbestos, mica, ceramics	0.1002	1.0000	Yes
Pearls, precious and semi-precious stones, precious metals	0.1735	1.0000	Yes
Base metals and articles of base metals	0.1826	1.0000	Yes
Boilers, machinery and chemical appliances, parts thereof	0.1790	1.0000	Yes
Vehicles, aircraft and parts thereof, vessels, etc.	0.3418	1.0000	Yes
Miscellaneous manufactured articles	0.2549	1.0000	Yes

Sources: Author's Work (2022)

10% 5% 1%

Critical values: 0.358 0.484 0.694

Table 4.1 shows that the series were all stationary at 5% level of significance.

Therefore, **the actual model is:**

$$Y_t = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \beta_4 X_4 + \beta_5 X_5 + \beta_6 X_6 + \beta_7 X_7 + \beta_8 X_8 + \beta_9 X_9 + \beta_{10} X_{10} + \beta_{11} X_{11} + \beta_{12} X_{12} + \beta_{13} X_{13} + \beta_{14} X_{14} + \beta_{15} X_{15} + \beta_{16} X_{16} + \beta_{17} X_{17} + e_i$$

Table 4.2: KPSS Test on the Log of Commodity Terms of Trade

Variable Statistics	Test Statistic (without trend)	P-Value	Stationary
Live animals, animal products	0.2917	1.0000	Yes
Vegetable products	0.1120	1.0000	Yes
Prepared foodstuffs, beverages, spirits and vinegar, tobacco	0.1413	1.0000	Yes
Mineral products	0.3448	1.0000	Yes
Products of the chemical and allied industries	0.1266	1.0000	Yes
Plastic, rubber and articles thereof	0.2408	1.0000	Yes
Raw hides and skins, leather, furskins, saddlery, etc.	0.1644	1.0000	Yes
Wood and articles of wood, wood charcoal and articles	0.3660	0.0970	Yes
Paper making material, paper and paperboard, articles	0.1095	1.0000	Yes
Textiles and textile articles	0.1613	1.0000	Yes
Footwear, headgear, umbrellas, sunshades, whips, etc.	0.2937	1.0000	Yes
Articles of stone, plaster, cement, asbestos, mica, ceramics	0.1122	1.0000	Yes
Pearls, precious and semi-precious stones, precious metals	0.1455	1.0000	Yes
Base metals and articles of base metals	0.1482	1.0000	Yes
Boilers, machinery and chemical appliances, parts thereof	0.1719	1.0000	Yes
Vehicles, aircraft and parts thereof, vessels, etc.	0.3375	1.0000	Yes
Miscellaneous manufactured articles	0.2540	1.0000	Yes

Sources: Author's Work (2022)

10% 5% 1%

Critical values: 0.358 0.484 0.694

Table 4.2 shows that all the variables are stationary at 5% level of significance.

Therefore, **the log model is:**

$$\ln Y_t = \beta_0 + \beta_1 \ln X_1 + \beta_2 \ln X_2 + \beta_3 \ln X_3 + \beta_4 \ln X_4 + \beta_5 \ln X_5 + \beta_6 \ln X_6 + \beta_7 \ln X_7 + \beta_8 \ln X_8 + \beta_9 \ln X_9 + \beta_{10} \ln X_{10} + \beta_{11} \ln X_{11} + \beta_{12} \ln X_{12} + \beta_{13} \ln X_{13} + \beta_{14} \ln X_{14} + \beta_{15} \ln X_{15} + \beta_{16} \ln X_{16} + \beta_{17} \ln X_{17} + e_i$$

Table 4.3: KPSS Test on the Square root of Commodity Terms of Trade.

Variable (Commodity Terms of Trade) Statistics	Test Statistic (without trend)	P-Value	Stationary
Live animals, animal products	0.2918	1.0000	Yes
Vegetable products	0.1019	1.0000	Yes
Prepared foodstuffs, beverages, spirits and vinegar, tobacco	0.1408	1.0000	Yes
Mineral products	0.3401	1.0000	Yes
Products of the chemical and allied industries	0.1372	1.0000	Yes
Plastic, rubber and articles thereof	0.2529	1.0000	Yes
Raw hides and skins, leather, furskins, saddlery, etc.	0.1955	1.0000	Yes
Wood and articles of wood, wood charcoal and articles	0.3594	0.0990	Yes
Paper making material, paper and paperboard, articles	0.1098	1.0000	Yes
Textiles and textile articles	0.1632	1.0000	Yes
Footwear, headgear, umbrellas, sunshades, whips, etc.	0.2851	1.0000	Yes
Articles of stone, plaster, cement, asbestos, mica, ceramics	0.1039	1.0000	Yes
Pearls, precious and semi-precious stones, precious metals	0.1602	1.0000	Yes
Base metals and articles of base metals	0.1656	1.0000	Yes
Boilers, machinery and chemical appliances, parts thereof	0.1753	1.0000	Yes
Vehicles, aircraft and parts thereof, vessels, etc.	0.3398	1.0000	Yes
Miscellaneous manufactured articles	0.2616	1.0000	Yes

Sources: Author's Work (2022)

10% 5% 1%

Critical values: 0.358 0.484 0.694

Table 4.3 shows that the variables are all stationary at 5% level of significance.

Therefore, **the square root model is:**

$$\sqrt{Y_t} = \beta_0 + \beta_1\sqrt{X_1} + \beta_2\sqrt{X_2} + \beta_3\sqrt{X_3} + \beta_4\sqrt{X_4} + \beta_5\sqrt{X_5} + \beta_6\sqrt{X_6} + \beta_7\sqrt{X_7} + \beta_8\sqrt{X_8} + \beta_9\sqrt{X_9} + \beta_{10}\sqrt{X_{10}} + \beta_{11}\sqrt{X_{11}} + \beta_{12}\sqrt{X_{12}} + \beta_{13}\sqrt{X_{13}} + \beta_{14}\sqrt{X_{14}} + \beta_{15}\sqrt{X_{15}} + \beta_{16}\sqrt{X_{16}} + \beta_{17}\sqrt{X_{17}} + e_i$$

Table 4.4: The three models parameter estimates with their model selection criteria and R-square using the Ordinary Least Square Method

Variables	parameters	Actual Model	Square root Model	Log Model
		Coefficient (p-value)	Coefficient (p-value)	Coefficient (p-value)
	Constant		-4762.28(0.06234*)	
X_1	β_1	170.948(0.08361*)	35.4679 (0.02249**)	4.57026(0.11971)
X_2	β_2	-198.122(0.02381**)	-51.3318 (0.01633**)	-5.76428 (0.09477*)
X_3	β_3	83.0833(0.42638)	149.932 (0.05517*)	1.99544(0.57163)
X_4	β_4	-61.8738(0.55666)	-8.39967 (0.37983)	-0.509404(0.90161)
X_5	β_5	-63.8009(0.23977)	75.4201 (0.06983*)	0.12033(0.91849)
X_6	β_6	59.0993 (0.33589)	54.7407 (0.05442*)	0.362828(0.85702)
X_7	β_7	121.741 (0.03344**)	56.2672 (0.02981**)	3.70562(0.12496)
X_8	β_8	79.0536 (0.30731)	-43.5824 (0.09348*)	0.230963(0.91848)
X_9	β_9	-163.409 (0.47456)	55.439 (0.12926)	-1.63834(0.72108)
X_{10}	β_{10}	-75.4816 (0.53725)	107.183 (0.07196*)	1.31815(0.74729)
X_{11}	β_{11}	-203.809 (0.03499**)	7.33032 (0.58907)	-5.27477(0.17640)
X_{12}	β_{12}	91.4601 (0.02595**)	-11.4204 (0.16239)	0.657679(0.19258)
X_{13}	β_{13}	19.7411 (0.69893)	-26.9134 (0.09434*)	0.875495(0.69209)
X_{14}	β_{14}	310.215(0.07304*)	-57.9736 (0.17174)	6.43792(0.24436)
X_{15}	β_{15}	-245.543 (0.16910)	15.906 (0.39761)	-2.93481(0.53990)
X_{16}	β_{16}	242.773 (0.25281)	168.802 (0.05133*)	1.74923(0.72663)
X_{17}	β_{17}	-78.3824 (0.59717)	-40.4655 (0.05542*)	-3.96321(0.28650)
	R-squared	0.991342	0.99578	0.999443
	Adjusted R-squared	0.945165	0.959986	0.996470
	Akaike criterion	347.6558	116.4013	25.56915
	Hannan-Quinn	350.9602	119.9001	28.87356
	Durbin-Watson	1.604915	2.495506	2.073443

Sources: Author's Work (2022)

Foot note:

Variables	Variable Names	Variables	Variable Names
X_1	Live animals, animal products	X_{10}	Textiles and textile articles
X_2	Vegetable products	X_{11}	Footwear, headgear, umbrellas, sunshades, whips, etc.
X_3	Prepared foodstuffs, beverages, spirits and vinegar, tobacco	X_{12}	Articles of stone, plaster, cement, asbestos, mica, ceramics

X ₄	Mineral products	X ₁₃	Pearls, precious and semi-precious stones, precious metals
X ₅	Products of the chemical and allied industries	X ₁₄	Base metals and articles of base metals
X ₆	Plastic, rubber and articles thereof	X ₁₅	Boilers, machinery and chemical appliances, parts thereof
X ₇	Raw hides and skins, leather, furskins, saddlery, etc.	X ₁₆	Vehicles, aircraft and parts thereof, vessels, etc.
X ₈	Wood and articles of wood, wood charcoal and articles	X ₁₇	Miscellaneous manufactured articles
X ₉	Paper making material, paper and paperboard, articles		

Sources: Author's Work (2022)

From Table 4.4, the square root model has highest number of significant parameter and will be the adequate model for the study. The following independent variables are significant in the square root model

- x₁ - Live Animals,
- x₂ - Vegetable Products,
- x₃ - Prepared Foodstuffs & Beverages,
- x₅ - Chemical & Allied Industries Products,
- x₆ - Plastic and Rubber and Cement Products,
- x₇ - Leather Products,
- x₈ - Wood Products,
- x₁₀ - Textiles Products,
- x₁₃ - Precious Metals Products,
- x₁₆ - Vehicles & Parts Products, and
- x₁₇ - Miscellaneous Manufactured Articles.

The results showed that the adequate model for the study is:

$$\sqrt{Y_t} = -4762.28 + 35.47\sqrt{X_1} - 51.33\sqrt{X_2} + 149.93\sqrt{X_3} + 75.42\sqrt{X_5} + 54.74\sqrt{X_6} + 56.27\sqrt{X_7} - 43.58\sqrt{X_8} + 107.18\sqrt{X_{10}} - 26.91\sqrt{X_{13}} + 168.80\sqrt{X_{16}} - 40.47\sqrt{X_{17}}$$

Discussion

This study examined the adequate model for the relationship between commodity terms of trade and money supply. The data were transformed to obtain the log data and square root data. The KPSS unit root test was used to determine whether the economic time series for the three sets of data were stationary or non-stationary. Table 4.1, 4.2, and 4.3 showed that the independent variables (commodity terms of trade) for the three sets of data were stationary. Since the data were stationary at 1%, 5% and 10% level of significance, we uphold the null hypothesis

H₀₁: The time series generated by the data is stationary

And reject the

H₁: The time series generated by the data is not stationary

And three models were generated based on the stationarity.

From table 4.4 using the ordinary least square, the actual model has six (6) significant parameters, R² = 99.1%, AIC = 347.66, BIC = 350.96 and DW = 1.60, the square root model has twelve (12)

significant parameters, $R^2 = 99.6\%$, AIC = 116.40, BIC = 119.90 and DW = 2.496, and the log model has one (1) significant parameter, $R^2 = 99.9\%$, AIC = 25.57, BIC = 28.87 and DW = 2.07.

The adequate model is the **square root model** which has the highest significant parameters, (x_1 - Live Animals, x_2 - Vegetable Products, x_3 - Prepared Foodstuffs & Beverages, x_5 - Chemical & Allied Industries Products, x_6 - Plastic and Rubber and Cement Products, x_7 - Leather Products, x_8 - Wood Products, x_{10} - Textiles Products, x_{13} - Precious Metals Products, x_{16} - Vehicles & Parts Products, and x_{17} - Miscellaneous Manufactured Articles), though the log model has the highest R^2 valued, smallest AIC and smallest BIC which should have made it the best model but those parameters came up as a result of transformation effect.

Conclusion and Recommendation

Based on the above results, it was concluded that the best model for this study was square root model because it has highest significant parameters (12) compared to the actual model (1 significant parameter) and log model (6 significant parameters).

It is therefore recommended that more detailed work be carried out using other transformation techniques (i.e another power transformation techniques) to identify a more suitable model to be used for the study or prediction of the variables.

References

- Akaike Information Criteria. (1974). A new at the statistical model identification. IEEE Transaction on Automatic control 19(0); 716-723. Doi; 10.119/TAC. 1974.1100705
<http://dx.doi.org/10.119%2fTAC.1974.1100705>MR0423716
<http://www.ams.org/mathscinet/item.mr=0423716>.
- Akpanta, A. & Iwueze. I. (2009). On applying the bartlett transformation methods to time series data. *Journal of Mathematical sciences* 20(3), 227-243.
- Bertrand, G. & Suhaib, K. (2019). Commodity terms of trade: A new database. *International Monetary Fund Working Paper*. <https://doi.org/10.5089/9781484393857.001>
- Biu, O., Arimie, O., Ebe, O. (2021). Commodity terms of trade and their effects on money supply in Nigeria. *International Journal of Researcrh and Innovation in Applied Science (IJRIAS)*, 2(6), 158-168.
- Bland, J., Altman, D. (1996). The use of transformation when comparing two means. *British Medical Journal*, 312(96), 1153-1163.
- Central Bank of Nigeria (2018a). Monetary Policy. <https://www.cbn.gov.ng>
- Collier, P. & Goderis, B. (2012). *Commodity prices and growth: An empirical investigation*. *European Economic Review*, 56(6), 1241-1260.
- Dehn, J. (2000) Private investment in developing countries: The Effects of commodity shocks and uncertainty. WPS, Oxford, 11
- Dickey, D. A. and Fuller, W. A. (1979). "Distribution of the estimators for autoregressive time series with a unit root", *Journal of the American statistical association*, 74(366a), 427- 431.
- Dickey, D. A., Bell, W. R. and Miller, R. B. (1986). Unit Roots in Time Series Models; Test and Implication, *American Statistician*, 40: 12-26.
- Kwiatkowski, D., Phillips, P., Schmidt, P. & Shin, Y. (1992). Testing the null hypothesis of stationarity against the alternative of a unit root, *Journal of Econometrics* 54(92), 159-178.
- Ndiyo, N. (2005). Fundamentals of research in bahaviourial science and humanities. Wusen Publishers.
- Otuonye, E., Iwueze, I. & Ohakwe J. (2011). The effect of square root transformation on the error component of the multiplicative time series model. *International Journal of Statistics and Systems*. 6(4), 461-476.
- Phillips, P.C.B. (1987). "Time Series Regression with a Unit Root," *Econometrica*, 55, 227-301.
- Phillips, P.C.B. and Perron, P. (1988). "Testing for Unit Roots in Time Series Regression," *Biometrika*, 75, 335-346.

Phillips, P.C.B. and Xiao, Z. (1998). "A Primer on Unit Root Testing," *Journal of Economic Surveys*, 12, 423-470.
 Spatafora, N. & Tytell, I. (2009). Commodity terms of trade: The history of booms and busts. *International Monetary Fund Working Paper*, 09-205.

APPENDIX

The data for commodity terms of trade and money supply

Years	Money Supply (M1)	Live animals, animal products	Vegetable products	Prepared foodstuffs, beverages, spirits and vinegar, tobacco	Mineral products	Products of the chemical and allied industries	Plastic, rubber and articles thereof	Raw hides and skins, leather, furskins, saddlery, etc.	Wood and articles of wood, wood charcoal and articles	Paper making material, paper and paper board, articles	Textiles and textile articles	Footwear, headgear, umbrellas, sunshades, whips, etc.	Articles of stone, plaster, cement, asbestos, mica, ceramics	Pearls, precious and semi-precious stones, precious metals	Base metals and articles of base metals	Boilers, machinery and chemical appliances, parts thereof	Vehicles, aircraft and parts thereof, vessels, etc.	Miscellaneous manufactured articles
2002	637.73	99.95	194.10	111.04	78.83	56.47	186.74	110.57	95.46	97.52	108.33	88.52	96.42	104.22	103.46	108.29	96.41	105.46
2003	816.71	71.68	151.25	106.58	91.81	126.48	104.50	101.37	96.08	93.83	105.00	83.28	110.81	118.14	104.70	95.79	96.58	100.01
2004	946.25	76.83	159.71	96.96	87.94	127.31	160.80	118.36	96.74	94.78	108.53	82.49	110.74	122.28	105.12	95.56	88.81	125.24
2005	1,225.56	57.06	152.66	72.99	90.47	121.33	171.44	173.93	87.76	67.13	134.80	85.62	92.19	110.05	105.79	106.58	84.38	103.78
2006	1,330.66	53.91	91.26	107.67	95.12	65.23	115.80	126.79	91.19	91.85	118.14	83.77	38.70	112.62	87.24	88.45	84.30	111.15
2007	1,725.40	79.88	106.14	93.03	96.28	91.94	116.69	99.13	92.87	95.31	103.48	83.96	27.65	108.89	96.49	92.36	99.19	109.25
2008	2,280.65	116.64	152.18	94.83	102.56	92.49	111.52	110.33	96.85	83.00	103.24	72.68	23.41	102.79	80.73	80.07	97.42	96.78
2009	3,116.27	83.13	136.70	107.46	109.29	118.12	101.60	114.09	90.65	91.70	105.50	82.77	112.75	109.98	104.14	95.82	92.33	100.29
2010	4,857.31	81.45	156.09	106.08	115.98	111.24	96.56	115.61	89.76	90.78	104.28	82.14	112.29	107.76	102.16	85.68	102.70	90.41
2011	5,017.12	77.06	140.78	109.59	110.56	120.36	96.86	126.41	93.05	88.92	106.16	81.03	114.53	110.63	101.33	95.99	92.02	103.64
2012	5,571.27	86.05	204.12	91.08	122.09	96.76	106.99	279.39	123.23	71.96	135.11	83.96	80.34	104.91	81.66	83.70	79.16	93.15
2013	6,771.58	75.79	73.89	72.38	133.47	48.31	112.47	179.63	187.01	55.19	227.98	99.78	65.28	115.04	64.60	90.74	89.51	134.61
2014	7,417.95	48.63	65.11	91.05	130.29	77.50	111.93	148.38	114.52	50.50	110.12	105.82	46.05	232.19	66.43	113.49	107.34	68.61
2015	7,025.14	75.70	130.19	93.24	116.92	91.59	114.96	187.63	132.11	64.27	129.55	98.72	44.89	183.07	83.49	99.19	96.51	94.41
2016	6,877.26	83.63	105.80	104.52	154.10	61.25	119.47	113.16	80.51	52.01	112.90	118.76	50.86	162.21	75.75	80.65	104.96	69.94

2017	8.57 1.70	203 .69	230. 43	116. 42	171 .82	69. 33	14 1.8 0	283 .35	23 3.4 0	90.5 6	13 0.4 6	313. 28	81. 41	18 3.8 1	15 8.5 4	91.8 7	95. 86	112.4 1
2018	11.2 71.5 1	224 .60	387. 32	107. 79	162 .35	83. 13	13 8.0 4	314 .28	22 7.4 5	139. 32	15 0.0 1	246. 02	103 .56	20 4.3 1	21 9.5 9	95.3 3	116 .48	136.9 9
2019	11.1 75.5 7	104 .97	116. 72	103. 46	105 .14	120 .80	10 6.1 8	59. 74	14 9.2 1	100. 67	12 7.0 9	88.6 6	100 .45	73. 05	13 6.6 6	125. 22	102 .40	85.03
2020	11.0 61.3 3	103 .57	104. 56	100. 88	98. 33	100 .83	99. 99	98. 83	10 2.9 9	104. 76	98. 95	100. 30	103 .18	98. 69	10 4.8 9	99.8 0	102 .14	101.7 3
2021	11.2 65.6 7	101 .59	101. 81	107. 26	101 .07	103 .95	10 2.4 6	98. 86	10 4.4 9	95.6 8	92. 22	90.8 1	85. 95	98. 30	99. 23	96.4 1	98. 30	96.86