A COMPARISON OF THE OUTPUT OF THREE ECONOMETRIC MODELS IN EVALUATING THE RELATIONSHIP BETWEEN TAXES AND ECONOMIC GROWTH IN NIGERIA.

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ABSTRACT

This study is set to compare the output of three econometric models – Linear, Log Quadratic and Transcendental Logarithm (Translog) – in evaluating the relationship between the major Nigeria taxes and economic growth using the gross domestic product (GDP) as a proxy, to guide policy makers.. The neutrality (the extent to which taxes are indifference to) or variability (the extent to which taxes are inconsistent with) the outputs of the three comparative econometric models The major taxes are value added tax (VAT), petroleum profit tax (PPT), custom and excise taxes (CEX) and company income tax (CIT). . Findings revealed that the output from the Linear and the Translog models were similar, but the output from Log Quadratic model was different. The choice of an econometric model in evaluating relationship should be carefully decided rather than being arbitrary. One of the criteria for selecting appropriate model is a graphical representation of the relationship of the variables. Policy makers would therefore be guided on the appropriate econometric model(s) to use.

Keywords:Nigerian taxes, Comparative econometric models, Economic growth.

1.0 INTRODUCTION

The Nigerian tax system is a collective package. Of about 40 different taxes in the federal, state and local government levels with three main tax bases. The CIT, PPT and personal income tax (PIT) had their bases on income. The VAT and Excuse duties had their bases on consumption while capital gains tax (CGT) had its base on capital. Other types can be slotted into any of the three bases. The incidences of the taxes are direct or indirect. Direct taxes are CIT, PPT and CGT but VAT and Customs and Excuse taxes (CEX) are indirect. Nigeria runs a federal political structure which creates a fiscal regime operated under the same principle. About eight taxes were controlled by the federal with the CEX inclusive. The States had about 12 different taxes while the local governments scrambled for 20 different taxes. This structure resulted in tax multiplicity between local and state governments and the states and federal governments. The tax system is basically structured as a tool for revenue generation but an ideal structure, apart from revenue generation, should be used for redistribution of income and wealth, a tool for economic regulation and for achieving the harmonization objective in the single market ECOWAS philosophy. It should be noted that the tax system is not without some challenges. It is characterized by unnecessary complexity, distortionary and largely inequitable taxation laws that have limited application in the formal sector that dominates the economy (Okuru 2012). In addition, Micah, Ebere and Umobong (2012) describe the tax system as lacking statistical data, with poor administration, lopsided and dominated by oil revenues. No tax system in our contemporary world is free from one challenge or the other. The federal government and stakeholders had discussed tax system at various forra with a view to correcting perceived flows in it. This paper focused on four major taxes which were at the exclusive legislative and administrative jurisdiction of the federal government of these taxes are; VAT, CIT, PPT and CEX.

Objectives of the Paper

This paper employed three different functions – Linear, Log Quadric and Translog functions to estimate the effects of the Nigerian Tax System on Economic Growth (GDP). Specifically,

. (a). To develop econometric models from the these three functions and compare the results.

(b) To employ and examine a bi-variate analyses noting whether the independent variables are neutral or revealed varied outcomes.

(c) To guide economic policy makers on using the appropriate model(s)

2.0 THEORETICAL AND CONCEPTUAL ISSUES

Various functions can be used to estimate the parameters of the taxes (VAT, CIT, PPT and CEX) it relation to economic growth. Among these are the linear, log linear and quadratic functions. Some production functions such as Cobb-Douglas, Constant Elasticity of Substitution, Log Quadratic and Translog functions shall also be discussed.

21. A Function

A function is a relationship between two or more quantities, usually in the form Y = f(X); interpreted as Y is a function of X or precisely, the value of Y depends on the value of X.

The term "Function" was first used in 1637 by the French Mathematician Rene Dos Certes (Boaggren and Singer,, 2009). Various elasticities are being estimated usingEengel curves for regression. A mathematical relationship between Y and X is:

$$Y = \propto_0 + \propto_1 X \text{ ---------------} \qquad \text{(eq 1)}$$

2.2 Functional Analysis of the Tax System and Economic Growth

Various functions can be used to estimate the effects of the tax system on gross domestic product (GDP) which is the proxy for economic growth. These include:

2.2.1 Linear Functions

A linear function is any function in the first degree. Such function (e.g. equation 1) can be restricted to a mathematical form.

$Y = \propto\_0 + \propto\_i\, Xi$ ……(eq 2)

Y = Independent variable

$\propto_0$ = Constant term

$\propto_i$ = An array of the coefficients of X;

Xi = The independent (or explanatory) variables.

Equation 1 can be extended as:

$$Y = \propto_0 + \propto_1 X_1 + \propto_2 X_2 + \propto_3 X_3 \dots \dots \propto_n X_n \quad (eq\ 3)$$

This function is of the type:

$$GDP = \propto_0 + \propto_1 VAT_t + \propto_2 CIT_t + \propto_3 PPT_t \propto_4 CEX_t + e_t \quad (eq\ 4)$$

2.2.2 The Cobb-Douglas Function

This is a production function by Cob and Douglas (1928) in the measurement of technological relationship between the amount of output, particularly physical capital and labour, and the amount of output that can be produced by these inputs (Wikipedia n.d.). The function is represented as:

$$Y = AL^B K^{1-B} \dots\dots \quad (eq\ 5)$$

Where:

Y = Total production

L = Labour input

K = Capital input

A = Factor productivity

$\beta, 1-\beta$ = Output elasticity of capital and labour respectively.

2.2.3 Constant Elasticity of Substitution Function

The constant elasticity of substitution (CES) functions as to take care of the rigid assumption of cob-Douglas function (Upender, 2003). The C-D function has unitary value of elasticity of substitution between labour and capital.

CES production function was the original specification of Arrow, Cherery, Minhas and Solow (1961). Later, Kmenta (1967) made some adjustments to the function. The original equation was:

$$Y = A.(\propto.K^B + (1-\propto).L^{\frac{1}{B}} \quad \dots\dots (eq\ 6)$$

Where Y = Output

A = Factor productivity

∝ = Share Parameter

K,L = Primary Production Factors (Capital and Labour)

β = (S-1)/S

S = 1/(1-β) which is the elasticity of substitution.

As its name suggests, the CES production function exhibits constant elasticity of substitution between capital and labour.

The CES and C-D Functions

The C-D production function is a special case of the CES production function. If β = 1, there is a linear function, if β approaches zero, in the limit, we get the C-D function.

2.2.4 **Transcendental Logarithmic Function (TLF)**

This production function has severally been abridged as translog function. The initiation may be traced to Kmenta (1967) where the CES was approximated from it within a Taylor series of second-derivatives.

The TLF is more of a transformation of the C-D and the CES function. The contribution of Christesen, Dorgensen and Lawrence (1973) cannot be over-estimated in the aspect of translog production possibility frontier. Today, one of the most commonly used methods to study output, profitability, value added growth and the like is C-D function and TLF. The function assumes that any function could be expressed with a Taylor series of one or more variables (Habib, 2014). The generalized form of the TLF which takes into account a number of an inputs can be expressed as:

$$L_nY = \propto_0 + \sum_{i=1}^{n} \propto_1 \; L_nX_i + \frac{1}{2}\sum_{i=1}^{n} \beta_1 \; (L_nX_i)2 + \sum C_{IN}(L_nX_i)\,(L_nX_N) \quad \dots \quad (eq\ 7)$$

This function is transformed into:

$$L_nGDP = A + \propto_0 LnVAT_t + \propto Ln_1CIT_t + \propto_2 LnPPT_t + \propto_3 LnCEX_t + e_t \quad \dots\dots \quad (eq\ 8)$$

The TLF is a flexible functional form for the production functions It has not assumed rigid premises of C-D function such as perfect or "Smooth" substitution between production. Factor or perfect competition on the production factors market (Klacek, Vosvida and Schlsser, 2007)

2.2.5 **The Log Quadratic Function [LQF]**

A log quadratic function used by Sargant (1971) defined a condition of relaxing the constraints imposed to the parameter in the Kmenta function in order to test the homotheticity assumptions, and was written as:

$$L_nY = L_nA_{KL} + \propto_k . L_nK + \propto_l . L_n + \propto_l . L_nL + \beta_{k^2} L_{n^2}K + B_L{}^2 Ln\ L + \beta_{kl} . L_nK \, . L_nL \dots \quad (eq\ 9)$$

This function of two input variables may be adjusted to, say, four input variables in the form:

$$L_nY = L_nA_{KLMN} + \propto_k . L_nK + \propto_l . L_nL + \propto_m . L_nM + \propto_n . L_nN + B_{K2}Ln^2 K + \beta_{L^2} . L_{n^2}L + B_{M}2Ln^2 \; M + B_N 2L_n 2N + B_{KLMN} L_nK \, . L_nL \, . L_nM \, . L_nN \dots$$

In estimating an economic function such as Tax and GDP, this function is of the type:

$$L_nGDP = A_{VCPX} + \propto_V . L_nVAT_t + \propto_C . L_nCIT_t + \propto_P . L_nPPT_t + \propto_X . L_nCEX_t + \beta_{V^2} . L_{n^2}VAT_t + \beta_{C^2} . L_{n^2}CIT_t + \beta_{P^2} . L_{n^2}PPT_t + \beta_{X^2} . L_{n^2}CEX_t + \beta_{VCPX} . L_nVAT_t \, . L_nCIT_t \, . L_nPPT_t \, . L_nCEX_t + e_t \dots\dots \quad (eq11)$$

2.2.6 Econometric Model

Econometrics deal with the measurement of economic relationship, a combination of economic theory, mathematic and statistics, but completely distinct from each of these three branches of science

(Koutsoyiamis, 2001). An econometric model possesses an important weapon in fulfilling the estimation function. This is the addition of a random term to indicate that it may not be possible for a set of variables to explain another valuable relationship 100 percent exact. Hence an econometric model of **equation 1** would be:

$$Y = \propto\_0 + \propto\_i \times\_i + e\_i \quad \dots\dots \qquad (eq\ 12)$$

Where

Y	=	Dependent variable
$\propto_0$	=	Constant term or intercept
$\times_i$	=	Independent variables
$\propto_i$	=	Independent variables' coefficients

$\{e_i\}$ = The stockastic error term assumed to be independent and normally distributed with zero mean and constant variance i.e. $e_i \sim \mu\ (0, \sigma^2)$. It is the addition of the error term that makes econometric models different from functional, mathematical or statistical relationship.. An implied summary of the various functions discussed would be a focus on three equations. First was equation 4 on linear function, equation 8 on translog function and equation 11 on log quadratic functions. These functions were already in the form of econometric models. We shall use these three models to estimate the tax system in relation to GDP. This would help to analyze the neutrality or variability of each of the functional estimators.

3.0 Methodology

3.1 Data Collection

The data used for this study were obtained from the Central Bank of Nigeria (CBN), 2013 Statistical Bulletin for the gross domestic product (GDP) at current purchasing prices from 1994 – 2012 on pages 197-109. The VAT, CIT, PPT and CEX were collected from CBN (2008) Statistical Bulletin and various previous issues. The VAT, CIT, PPT and CEX from 2009-2014 were collected from CBN (2009-2014) Annual Reports. The various annual reports pages were (2009) pages 94-96; (2010) pages 92- 95; (2011) pages 102-104; (2012) pages 100=102; (2013) pages 154-156 and (2014) pages 112-114.

Table 1: The GDP 1994 – 2011, and the Respective Taxes [VAT, PPT, CEX, and CIT]

Year	**GDP at Cpp**	**VAT**	**PPT**	**CEX**	**CIT**
1994	946	7.3	43	18.3	12.3

1995	2009	20.8	43	57.4	21.8
1996	2799	31	76.7	55	22
1997	2907	34	68.6	63	26
1998	2816	37	68	58	33
1999	3312	47	164	88	46
2000	4717	58.5	525	101.5	51
2001	4910	91.8	639	171	69
2002	7128	108.6	392	181.4	89
2003	8743	136.4	683	196	115
2004	11674	159.5	1183	217	113
2005	14735	178.1	1905	233	140
2006	18710	230.4	2038	178	245
2007	20941	301.7	1601	241	275
2008	24665	404.5	2150	281.3	417
2009	25256	468.4	1256.5	297	500
2010	34495	562.9	1944.7	309	658
2011	38151	649.5	3976.3	438	701
2012	41777.82	709.8	4365.4	475.8	849.1
2013	63942.85†	795.6	3719	433.7	985.5
2014	67977.46†	794.2	3439.6	566.2	1207.3

Source: CBN Statistical Bulletin (2013: 95-141) and other previous issues.

CBN Annual Reports (2009-2014),

†CBN Annual Economic Report (2014: 260-Table 38), provisional. All Naira values are in ₦'000M. `

3.2 Models Specification

Three comparative models would be specified from the various functions discourse especially equation 4, equation 8 and equation 11 for Linear model, Log Quadratic Model and the Trans-log model are specified:

Model Specification 1[Linear Model]

$$GDP_t = a_0 + \propto_i VAT_t + \propto_i VAT_t + a_2 CIT_t + a_3 PPT_t + a_4 CEX_t + e_t \quad (eq\ 13)$$

Where:

GDP = the gross domestic product which is a proxy for economic growth and as the dependent variable.

a_0 = the constant term or the intercept.

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a_1- a_4 = the array of coefficients of the independent variables

$VATt\ CIT_t\ PPT_t CEX_t$= the four explanatory variables as explained

e_t = Stochastic error term.

Model Specification 2 [Log Quadratic Model]

$L_nGDP = A_{VCPX} + \propto_V L_nVAT_t + \propto_C L_nCIT_t + \propto_P L_nPPT_t + \propto_X L_nCEX_t + \beta_{V^2}L_{n^2}VAT_t + \beta_{C^2}L_{n^2}CIT_t + \beta_{P^2}L_{n^2}PPT_t + \beta_{X^2}L_{n^2}CEX_t \quad \beta_{VCPX} L_nVAT_t . L_nCIT_t . L_nPPT_t . L_nCEX_t + e_t$ … ….

Where

$LnGDP$ = Natural Logarithm of the gross domestic produc as the dependent variable and a proxy for economic growth.

L_nA_{vepx} = A constant or intercept

$\propto_v$, $\propto_c$, $\propto_p$and $\propto_x$ = The array of the coefficients of the L_nVAT_t, L_nCIT_t, $L_nPPT_t$and L_nCEX_t respectively.

B_{V^2}, B_{C^2}, B_{P^2} and B_{X^2}= The array of the coefficients of the $L_{n^2}VAT_t$, $L_{n^2}CIT_t$ $L_{n^2}PPT_t$and $L_{n^2}CEX_t$ in the second degree respectively..

B_{VCPX} = The coefficient of the product of, L_nVAT_t, L_nCIT_t, $L_nPPT_t$and L_nCEX_t represented by VCPX [$V=L_nVAT$, $C=L_nCIT$, $P=L_nPPT$, $X=L_nCEX$]

L_nVAT_t, L_nCIT_t + $L_nPPT_t$and L_nCEX_t = Independent variables of the first degree logarithm.

$L_{n^2}VAT_t$, $L_{n^2}CIT_t$ $L_{n^2}PPT_t$and $L_{n^2}CEX_t$ = Independent variables of the second degree logarithm.

L_nVAT_t., L_nCIT_t. + L_nPPT_t . L_nCEX_t = The product of the logarithms of the independent variables. These variables are represented by (VCPX)

e_t = Stochastic error term

Model Specification 3 [Translog Model

$LnGDPt = A + \beta_o LnVAT + \beta_1 LnCITt + \beta_2 LnPPTt + \beta_3 LnCEXt + \varepsilon_t$ $(eqn\ 15)$

Where: $(eq14)$

L_nGDP_t = Natural logarithm of gross domestic product as the dependent variable, and a proxy for economic growth.

A= The constant or intercept

L_nVAT_t, L_nCIT_t + $L_nPPT_t$and L_nCEX_t= Independent variables at the period t

β_1 to β_3= Array of coefficients of the independent variables

ε_t = Stochastic error term

Results and Discussion

The econometric equations 13, 14 and 15 were used to estimate the coefficients of the independent variables. Table 2 showed the GDP estimation model of equation 13 in the following results.

GDP = 423.4 + 68VAT - 19.51CIT + 1.86PPT + 12.74CEX (eq. 16)

VAT was positively significant at 10 percent level. CIT was negatively related;

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PPT and CEX were positively related. The Adjusted $R^2$was 0.987 showing that the four independent variables could jointly explain 98.7 percent of the variations in the GDP. The d.w. statistics was 1.595, F ratio was 36 showing that the regression was well fitted. The standard error was 1794 which was a bit high compared to the standard errors of coefficients with VAT having the highest of 36.02.

Table 3 showed the GDP estimation model of equation 14 in the following results.

L_nGDP = 3.37 + 0.475 L_nVAT + L_nCIT – 0.371 L_nPPT

+ 0.584 L_nCEX + 0.031$L_{n^2}VAT_t$+ 0.256$L_{n^2}CIT_t$

+ 0.027 $L_{n^2}PPT_t$ - 0.121$L_{n^2}CEX_t$+ 0.002 (VCPX) (eq 17)

. In Table 3, L_nCIT was positively significant at 10 percent, $L_{n^2}CIT$ was negatively significant at 10 percent and product of the L_n variables, L_n(VCPX) was positively significant at 10 percent. This model support CIT as being significant as against model I where VAT was supported significant. The adjusted R^2 was 0.994 showing that the independent variables jointly explained 99.4 percent of the variation in L_nGDP. Other indices such as the d.w. statistics was 2.139, F ratio was 331 showing a well fitted regression and the standard error of estimate was 0.094. Apart from L_nCEX, all the standard error of coefficients were less than unitary.

Model 3

Table 4 showed the GDP estimation model of equation 15.. The resulting equation was:

L_nGDP = 4.996 + 0.668L_nVAT+ 0.190L_nCIT + 0.065L_nPPT – 0.084L_nCEX - --- (eq 18)

Only L_nVAT was positively significant at 5 percents L_nCIT and L_nPPT were positively related to L_nGDP but L_nCEX was negatively related. The adjusted R^2 was 0.996 showing that 99.6 percent of the variation in L_nGDP was explained by the joint independent variables. The d.w. statistics was a bit low, being 1.028 but the F ratio of 327 and standard error of estimate of 0.141 showed that the regression was well fitted around the estimated L_nGDP. This model supports L_nVAT as being significant. The result was in agreement with model I to a reasonable extent.

The Comparative Econometric Models

The three important indices to be compared on the basis of Neutrality (N) or Variability (V) in the three models are the significance of the variables, the Adjusted R^2 and the F ratios. For the purpose of comparison, *VAT*, *L_nVAT* were just *VAT* and *Ln CIT, Ln2CIT* were just *CIT*.

Out of the three statistical indices tested, each model combination had two indices in common. The most important of

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the indices was the significance or otherwise of the independent variables to the GDP. Using the three criteria, one would tend to conclude that only models 1 and 3 satisfied all the three criteria and therefore the tax system was neutral to models I and 3 because VAT and L_nVAT were both significant. Model 2 presented a different tax relationship entirely; L_nCIT and $L_{n^2}CIT$ were significant. If log quadratic had been used, the attention of the economic policy makers would had shifted from VAT to CIT.

Conclusion and Recommendation

This study had examined the neutrality or variability of the Nigerian tax system to the linear; log quadratic and trans log functions. These analyses showed that the tax system is averagely neutral to linear and translog models. There is a variation in the case of log quadratic model.

The study therefore recommends that two or more different functions can be used to evaluate the relationship between the dependent and the independent variable(s). This would guide economic policy makers as to the outcome to be used. Also, a graphical representation of the dependent and independent variables(s) would be an added advantage and "on the spot" check on the type of functions and econometric models(s) to be used.

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APPENDIX*

Table 2: The Linear Model

Coefficients

Model	Unstandardized Coefficients		Standardized coefficients	T	Sig	AR^2	d.w	F ratio	StdEof Est
	B	Std. Error	Beta						
1 (Constant)	-623.410	783.364		-796	439	0.987	1.595	360	1794
VAT	68.074	36.024	1.080	1.890	.078	-	-	-	-
CIT	-19.508	23.880	-347	-817	.427	-	-	-	-
PPT	1.681	1.337	132	1.258	228	-	-	-	-
CEX	12.737	12.635	135	1.008	.329	-	-	-	-

a. Dependent Variable*: GDP*

Table 3: The Log Quadratic Model

Coefficients

Model	Unstandardized Coefficients		Standardized coefficients	T	Sig	AR^2	d.w	F ratio	Std Eof Est
	B	Std. Error	Beta						
1 (Constant)	3.370	2.781	-	1.212	.253	.994	2.139	331	0.094
L_nVAT	.475	.931	.537	.511	.671	0.994	-	-	-
L_nCIT	1.685	.868	1.945	1.941	.081	-	-	-	-
L_nPPT	-371	.426	-502	-870	.405	-	-	-	-
L_nCEX	.584	1.268	.446	.461	655	-	-	-	-
$L_{n^2}VAT$	.031	.122	.327	.255	.804	-	-	-	-
$L_{n^2}CIT$	-.256	.121	-2.845	-2.119	.060	-	-	-	-
$L_{n^2}PPT$	.027	.041	.435	.656	.527	-	-	-	-
$L_{n^2}CEX$	-.121	.142	-.895	-.854	.413	-	-	-	-
L_nVL_nCL_nP L_nCe	.002	.001	1.538	2.197	.053	-	-	-	-

a. Dependent Variable: L_nGDP

Table 4: The Trans Log Model

Coefficients

Model	Unstandardized	Standardized	T	Sig	AR^2	d.w	F	StdEof

	Coefficients		coefficients					ratio	Est
	B	Std. Error	Beta						
1 (Constant)	4.996	.365	-	13.703	.000	0.986	1.028	327	0.141
L_nVAT	.668	.272	.754	2.451	.027	-	-	-	-
L_nCIT	.190	.180	.219	1.055	.308	-	-	-	-
L_nPPT	.065	.071	.088	.921	.372	-	-	-	-
L_nCEX	-.084	.190	-.064	-.440	.666	-	-	-	-

a. Dependent Variable: *L_nGDP*

Table 5 Summary of the Three Models

Variable	Model	t-value	AR^2	d.w.	F ratio	Std error of estimate
VAT	1	1.89 (0.078)	0.987	1.595	360	1794
$L_n CIT$	2	1.945	0.994	2.139	331	0.014
		(0.081)				
$L_{n^2} CIT$	2	-2.119				
		(0.060)				
L_n(VCPX)	2	2.197				
		(0.053)				
$L_n VAT$	3	2.451	0.986	1.028	327	0.141
		(0.027)				

Extract from Tables 2 - 4

Table 6; The Bi-variate Analyses

Table 6a Models 1 and 2.

S/N	Particulars	Model 1	Models 2	Neutral(N) or Vary(V)
1	Significance of Variables	VAT	CIT	V
2	Adjusted R^2	0.987	0.994	N
3	F ratio	360	331	N

Table 6b Models 1 and 3

S/N	Particulars	Model 1	Models 2	Neutral(N) or Vary(V)
1	Significance of Variables	VAT	VAT	N
2	Adjusted R^2	0.987	0.986	N
3	F ratio	360	327	N

Table 6c Models 2 and 3

S/N	Particulars	Model 1	Models 2	Neutral(N) or Vary(V)
1	Significance of Variables	CIT	VAT	V
2	Adjusted R^2	0.994	0.986	N
3	F ratio	331	327	N

*SPSS 21 Output