

Transposition of Linear Regression Equations: A Myth or Reality?

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ABSTRACT

The purpose of this research is to ascertain the realism or the myth which surrounds the process of transpositions of linear regression equations; this is with a view towards revealing whether or not changes could occur in the transposed ones.

Using Linear equations derived from various budgetary allocations as dependent variables) to various sectors of the economy as well as other parameters as (Independent variables), the research examines if there exists significant departures from the outcome of the status of the initial regression equations and those resultant of the transpositions. Research findings revealed that several of the equations of transposed linear equations, when compared against those of the initial ones did not establish significant departures in terms of the status of the relationships from the earlier ones. The results of this research presents basis for further exploratory studies on the impact of transpositions of regression equations on the status of the parameters as well as the extent of the significance of relationships for future research.

Keywords:

(i) Statistics & Statistical Techniques (ii) Regression models (iii) Best lines of fits of straight line equations (iv) Simple and Multiple Regression models (v) Transpositions of linear Regression models (vi) Budgetary Allocations & Demographics

INTRODUCTION

Statistics is a field of study which aids in the collection, administration of data, it also involves analysis, the interpretation and discussion of data for purpose of obtaining or useful information that throws more light on phenomenon, the relationship between variables or parameters, some trends and their associated time series. These information obtained are useful for relevant decisions, management information services and for projection and forecast of trends and phenomenon. The usage/application of statistics for the purposes of the above mentioned involves an array of operations and processes to be undertaken before the data collection could be meaningfully applied. Transpositions of linear regression models is one of such techniques which converts linear regression equation to their nonlinear formats, exponentials as well as polynomial. The transposition of linear regressions would seem a misnomer; this derives its premise from the fact, that equations derived from this statistical process seldom show the

expected results. Transpositions of the linear equations to their nonlinear formats rarely showed significant departures from the earlier ones.

Based on the above assertions, this research sets out to review and determine from previous research works, if significant departures could occur on earlier linear models, adopting transpositions technique, this is also with a view to ascertain the extent of the significance or departure of the derived equations resultant of the transpositions.

The following issues justify the undertaking of the study: (1) The study further reveals the importance of statistics as well its usage as a discipline which through its empirical analytic potentials aid in the collection, collation and analysis on some phenomenon, trends and issues; the outcome of which forms basis for decision making: The outcome of the study, will further provoke the thinking process which focuses on the best lines of fit of straight line equations and its subsequent applicability as well as reliability as a statistical tool that enhances the efficacy of derived regression model. Evidences are abound that the usage of regression models as an empirical technique towards the explanation of research outcomes and phenomenon are common. There would however appear a relatively paucity on research works undertaken to ascertain the veracity of the essentialities of transpositions of formats to other nonlinear and the impact on outcome of the transitions. Based on the above assertion, there is therefore a need for a study that gives credence towards undertaking a transposition exercise. The study, is further justified, it has the capacity to likely bring to barest minimum, the cumbersome efforts associated towards embarking on transposition exercise, if it is eventually found not to be too relevant as it relates to the chosen parameters as well as statistical techniques. This research, in this regard is one of such efforts towards ascertaining the importance of transpositions of equations. The outcome of transpositions of the linear equations will also form basis and improve as well enhance decisions taken as they relate to the chosen parameters of this research. Following the above as a corollary, is the fact that the chosen parameters (budgetary allocations, its prices and that of other building materials) are vital economic indices that influence the capital developments of locations. (The following constitute the derivable benefits for undertaking the result). The locations wherein the parameters are chosen, Kogi Lokoja (a conference) town in Nigeria as well as Port Harcourt capital city of Rivers State an oil and gas state), play significant roles in human and economic geography of Nigeria.

The study will reveal if it is actually necessary to embark on transpositions. The study, thus stands as a fulcrum for determination of further studies on the need for transposition of linear equations. The study further has the potential of creating awareness as it concerns the usage of statistical techniques as vital tools for management information services and decision making. The chosen parameters, budgetary allocation figures and demographic provide vital sources of data as well as information basis for the determination, projection forecast of economic indexes and indicators; the chosen parameters are also vital for cost management of infrastructure.

Linear transpositions of regression equations are undertaken to establish whether the best lines of fit of straight line equations can give rise to nonlinear models. In this regard, the following are the objectives of the study:

(1) Provide a review on the existing processes and procedures which guide the undertaking of transpositions of linear equations. (2) Examine and reveal if transpositions of linear equations,

can give rise to other non-linear formats (exponentials, polynomials) or it is a misnomer. (3) Determine using the research methodology of previous research as basis, if the results of the transposed equations from those results actually followed the guides, processes and procedures which guide the transpositions of linear models. (4) Determine, if there exist significant departures amongst the outcome of several of the transposed linear equations, when compared against the earlier linear ones. (5) Determine, using the statistical tool of percentile as basis what proportion of the derived transposed linear equations gave rise to other formats nonlinear ones as well as showed significant departures.

The bounds and limits within the results of this research hold are as follows: The variables of the regression equations which are subjected to transpositions are (i) Budgetary allocations of secondary schools physical infrastructure development, within the stated time series. (ii) The Demographical Variables. The data of the Parameters of the study were obtained from Rivers State as well as Kogi State of Nigeria. The analysis of the results of the Linear equations against those of the transposed ones were undertaken using archival data, comparison technique as well as the statistical technique of percentile which expresses the extent to which transposed equations showed significant departures from the earlier linear ones.

RESEARCH QUESTIONS

Evidences are abound that Linear Transpositions of regression equations of several variables did not result in significant differences between the initial linear equations and those of the transposed ones. The study attempts to answer the following Questions: (1) Were the array of processes and procedures involved towards undertaking a linear transposition of linear equations, adhered to, before the derivation of the nonlinear formats? (2) Is the data as well the compilation process and procedure used for administration of the initial linear equations realistic and suitable parameters for undertaking the statistical operation? (3) Was it appropriate to have undertaken a transposition on the chosen parameters obtained from the data as well as the archival researches? The outcome of research as well as and its reliability may perhaps be limited due to adoption of the statistical technique, percentile used for the analysis between initial linear equations and the transposed ones. The application of other forms of statistical/empirical techniques may perhaps well enhance the validity and reliability of the results in future researches.

The following are assumptions that can give impetus to the acceptability of the results of the research. The archival data obtained as it relates to the parameters/variables of the equations were still current and contemporary. The initial linear regression equations as well the transposed ones, followed the appropriate processes needed for the undertaking a transposition exercise. The best lines of fit that led to the initial line or models, were realistic.

PREVIOUS STUDY:

The research work draws from earlier studies on the research focus, transpositions of regression equations. The study adopts case studies approach using archival records highlighting the parameters as well as results which showed in tabular formats the linear regression equations as well as the transpositions undertaken and resultant models: See for example the, study of Mac-Barango and Mbamali (2015), as well as that of Mac-Barango and Shittu (2015). Both studies present the results of an array of linear equations as well as those derived from the transpositions of the linear ones. Mac-Barango and Mbamali (2015), presents results from the study entitled

Analysis of budgets for public secondary schools, whilst that of Mac-Barango & Shittu (2015), is entitled the impact of budgetary Allocations on the prices of building materials.

REVIEW OF RELATED LITERATURE: STATISTICS AS AN EMPIRICAL DISCIPLINE & TECHNIQUES'

THE CONCEPT OF STATISTICS:

This segment of the study focuses on providing literature that discusses the study of statistics as a science based discipline as well as a technique/tool that aids in computation and analysis of variables, trends and phenomenon during the course of variant types of research works.

Butler and Bathurst (1980), also revealed statics as a science based course that has empirical attributes, reiterating that at the elementary level, the subject is simple mathematics feared with the adoption of a number of statistical conventions and that at the advanced level the methods, are dependent on probability theories. Essi (2010), defines statistics as a branch of mathematics or science that deals with methods of planning experiment for obtaining data and drawing. Conclusion or making useful decisions on the basis available data. Based on the aforementioned assertions it would appear reasonable to deduce as well as consider statistics as an empirical study that dwells on the collection of data, the processes and procedures by which data is collected, collated and subsequently analyzed so as to derive some information that forms the basis of management and decision making, bordering on some phenomenal issues and trends.

THE PURPOSE AND USES OF STATISTICS:

Statistics as an empirical discipline has various purposes, which are potentially relevant when undertaking research on scientific, as well as other economic, geo-socio phenomenon and trends” Butler and Bathurst (1980), also corroborated that statistics provides a means through which sets of data procedure can be adopted to decide, if the sets of data are representative of a wider group and whether the data could be considered as applicable to the whole gap. According to Daramola (1995), statistics as a subject area serves the following purposes: The quantification and analysis of data as to arrive at concise and meaningful decisions on hypothesized relations. Daramola, furthermore advanced the following as other purposes of statistics: descriptions of research variables, techniques for drawing up inferences on the characteristics of certain variables, population, trends and phenomenon as well as a useful tool towards the analysis, comprehension and interpretation of research reports.

The Variant Types of Statistical Techniques and Usages:

There exist variant statistical techniques that are employed towards the realization and attainment of functions of statistics: An array of these techniques are: Average and Semi-interquartile range, standard deviations, variance and skewness of distribution. Representative figures, the mean and interquartile range, mode, harmonic mean, geometric means, distribution curves, scattered charts, others are linear and multiple regression models, Non-linear regression equations, cost models and simulations.

The selection and usage of the variant techniques as tools of research are guided by an array of conditionality: According to Ashworth (1988), the choice of a statistical technique is based upon

adequate and reliable, observation, experience and intuition that relies on “right feeling” with due cognizance to limitations and thinking that has largely been towards a common sense method of understanding: The choice of Statistical techniques provide the tools and means through which the evaluation and analysis of collected and collated data are undertaken for purpose of deriving information on some trends, phenomenon and issues.

STATISTICAL TECHNIQUES AND THEIR FUNCTIONS:

ESSI (2009), headings offers articulated explanations on the usage as well as applications of some of these measures of central tendencies, measures of dispersions as well as measures of prediction and forecasts of variables, trends and phenomenon.

Explanations on the applicability of regression analysis as a statistical technique and its focus as a research too is extant reviewed elsewhere. See for example, Ashworth (1988)’s articulation which forwards explanations on the technique of regression as a mathematical formula or mathematical model which best describes data collected, where the variables to be tested have natural linearity. Woodridge’s (2016) headings provide common concepts and terms that form the basis for literature review on regression analysis as well as its applicability as a technique for undertaking research and as a mathematical model: Dependent and independent variables, explained and explanatory, response and control variable, predicted and predictor variable and regressed. Further terms are the origin of the straight line, error term or disturbance in the regression relationship, this represents factors other than X that effect Y. Unobserved factors, the slope parameter and the intercept parameter sometimes called the constant term.

The usage of regression analysis as a statistical technique is manifest in several ways. The assertions of Koutsonyiannis (1977), Dominick (1987) and Morenikeji (1999) have observed that regression shows the variables as well as to the derivation of an equation, which predicts one variable from another (the dependent (X), from the independent (Y)). The regression equations are also subject to uncontrollable sources of error. Hamburg (1979), in a similar vein opined that the purpose of regression equation is to provide estimates for values of dependent variable. The device used to accomplish this estimation process is the regression line.

REGRESSION MODELS

Regression is one of the statistical technique used for analysis of variables in the course of researches, and subsequently giving rise to a couple of outcomes. ESSI (2009)’s ascertain explained and revealed the applicability as well as the outcome of regression as a statistical technique as one, which study’s the relationship between two or more variables for purposes of establishment of functional mathematical form such as relationships. The established relationship can give rise to positive or negative models, straight line equations, parabolic or other forms exponential, polynomial or relationships complex. In certain circumstances the diagram may possibly suggest there is no correlation between the variables.

REGRESSION EQUATION

The straight line, in a regression equation is used to accomplish the estimation or prediction process of the dependent variable from values of the independent variables. The applicability of straight line in this research involves (i) The impact or observation of the outcome of some budgetary parameters which were estimated from other budgetary parameter. (ii) In a similar vein, the straight derived from the outcome of some budgetary parameters were estimated from

values of some parameters (the prices of some building materials) as independent variables. (iii) Demographics of students population was used for the prediction of capital budget for Secondary Schools (see outcome under Appendix).

Hamburg's (1979), Formula buttress the above as it relates to the prediction estimation process for parameters, using the regression as a mathematical device. David (1981), in a related perspective provides headings that further amplifies and explain the relationships between the dependent and independent variables, in a linear model: The straight line equation, which is given in the form, $Y = a+bX$, where Y and X are the independent and dependent variables respectively. Other terms include, the coordinates or ordinates, whose values satisfy the equation, the line of origin, the slope of the line, the intercept, the co-efficient. The line is referred to as regression line and the equation used to obtaining the regression equation.

There exist differentials between simple and multiple regression equations, this is manifest in the format, as well as the parameters of the equation. The general multiply regression model in expressed as $Y = a+b_1X_1 + b_2X_2 + b_3X_3 + \dots + b_nX_n$ where y, is the dependent variable, a, the regression constant, whilst $b_1, b_2, \dots, b_n =$ the regression coefficient, $X_1, X_2, \dots, X_n =$ the independent variable

Woodridge (2016), provide extant literature reviews explaining issues and terms associated with the applicability of multiple regression as an analytic technique. These include a technique to build better models for predicting and explicitly controlling other factors that simultaneously affect the dependent variable, useful for explaining y, identification of more variation in y.

TRANSPOSITIONS OF VARIABLES IN REGRESSION MODELS

Where considered necessarily transformation are employed to determine the extent of relationship existing between two or more variables. The transpositions of variables, to their exponential and polynomial formats (Quadratic, Square and Cubic roots formats were undertaken in consideration to find better fits for the initial linear models deprived. Transpositions of linear regression equation to their non-linear formats have propensity to provide better forecast. Prediction of values of one or more variables of an equation from another. The dependent variables which in this research population demographics are and in certain instances prices and budgetary parameter were to forecast project the budgetary allocations. The earlier initial linear models so derived when transposed were observed to ascertain if significant changes occurred in the values and forms of the parameters. Transpositions can change values and forms of the parameters and models so derived.

BUDGETS AND BUDGETARY ALLOCATIONS:

The budget is an economic tool that plays vital role in the economy of nations. These economic roles include planning, controlling as well as the appropriation of a country's resources/wealth distribution amongst the various sectors of the economy as well as private organizations. Adetola's (1999), emphasizing further roles of the budget as an economic tool, has identified the following economic functions: The planning and controlling of income and expenditure as well as the conversion of a company's plans and as objectives into quantitative and monetary terms.

The arrival of budget figures are governed and guided by a sequence of principles and procedures which could be termed as budgeting. Wahab (1999), in a related perspective has seen

budgeting as the process that predetermines proposed expenditure and income as well as translates them into targets that are to be achieved over a period; this target so achieved could be referred to as budget. Umoren (1994), also sees the budget as an economic tool that aids in economic analysis for physical infrastructure that embodies an estimate of proposed expenditure as well as the proposed means of financing the expenditure. Budgets in most instances are expected to ensure that spending should generally coincide with the projected appropriations. In this regard an array of variables have been identified to influence the efficacy of budgetary allocation. Hillenbrand (1974), identified the variables of inflation, foreign exchange, balance of payments, government monetary and fiscal policies and other programme of economic growth and social advancement as having very high levels of propensity to impact on the budgets and budgetary allocations. Seeley (1983), is also in agreement that expenditures like government fiscal and monetary instruments as well as policies on expansion of public works can potently impact on the budget and budgetary allocations. Shutt (1988), as a proponent, who also sees externalities as having impact on budgets and budgetary allocations have revealed that the whole spectrum of social benefits is under the direct control of government, employing an array of aggregated variables which include legislation, fiscal instruments of taxation, employment and unemployment polices, monetarist policy; using such instruments of supply of money, interest, rate regimes, price and wage restraint policies. Dikko (1999), further reveals and buttresses other variables which aside macro-economic policies that can also impact on budgets and budgetary allocations as population, Land constraint, increases in material, labour and equipment prices etc. Dikko's assertions is closely connected to private participants and their activities within the economy. The above mentioned policies and programmes can significantly influence the quantum of budgetary allocations.

THE IMPACT OF DEMOGRAPHICS ON BUDGETARY ALLOCATIONS FOR PUBLIC SECONDARY SCHOOLS.

Aside macro-economic variables, there are other variables which influence the quantum of budgetary allocations for public infrastructure development. Budgetary allocations to the educational subsector and subsequently to development of public secondary schools infrastructure is not an exception. Secondary schools need the following physical infrastructure: Classrooms, dormitories, dining halls, offices, laboratories etc. secondary schools infrastructure are vital to the growth of youths, the educational sector and indeed national development. UNESCO (1970)'s headings provide basis and considerations to be made in the course of provision for physical infrastructure for secondary schools: (i) Analysis for adequacy of the functional spaces (facilities) (ii) The design requirements (iii) Financial implications. The analysis on the design requirements focuses on the following variables location of the project, the use to which infrastructure is intended, the demographics obtained via anthropometric principles as well gender. Vaughan (2010)'s articulations serves as further revelations on the headings that form basis for discussions on the place and importance of secondary schools buildings as well as the variables which influence the provision: These variables are the type, nature, size of proposed infrastructure, the learning process or type of educational system and format as well as other design considerations.

RESEARCH METHODS:

This research is majorly affected through reviews as well as case studies on previous works. The study also draws from existing knowledge, undertaking literature reviews as well as analysis on

(various budgetary, parameters, population and other demographics) and impact on budgetary allocation for physical infrastructure development for public secondary schools. The study uses archival records and observations on the results of previous studies, which served as data for this study; concentrating on various parameters, the forms and pattern of the regression equations as well as the interpretation and discussion on outcome of the comparison between parameters of the previous study and those of this research.

TOOLS (ANALYTIC TECHNIQUE):

Based on the results of the Regression equations derived from the tested parameters, the transpositions of the linear equations, the study undertakes a further probe towards revealing if there exist significant, departures from the initial linear regressions and those of the transposed ones. The transpositions of the equations of the initial regression equations were undertaken fundamentally to determine the nature of the relationship between two or more variables (e.g. log, square roots, cube roots etc.) were considered in attempts to find better fits for the data collected and subsequently for the equations so derived. In so doing the statistical technique of percentile, was adopted as the observatory tool to ascertain to what extent the linear equations of the previous studies differ from the transposed ones.

Using data obtained through archival records the research undertakes the analysis, the observations as well as the comparison of the various linear equations against those of the transposed ones for details. (see Tables 4.3 and 4.4), pages 96 & 98 as published on the study of Mac-Barango & Mbamali (2015), entitled Analysis of Budgets for Public Secondary Schools, see also tables (2, 3, and 4), pages 201 & 202 as published on the study of Mac-Barango & Shittu (2015), entitled Budgetary Allocations to the Housing Sector and the price of some selected building materials.

The statistical technique of percentile formed the basis of the analysis and comparison of the initial established linear equations between and amongst the outcome of the transposed ones. The statistical technique of percentile was employed to fundamentally ascertain what proportion of the total initial linear equation when transposed, established significant departure from the initial ones. The choice of percentile as the statistical technique for this analysis and comparison of the sets of regression equations (linear and the transposed was considered appropriate for the research on the premise that same technique was adopted in Mac-Barango (2015)'s research. The study as the case with this, was set out to establish if there exist percentage differentials between and amongst different types of variables. In a related perspective, the study of Wafer Meyer (2015), also employed the same technique in the comparison of proportions between/amongst variables.

DISCUSSIONS ON THE RESULTS OF THE TRANSPOSITIONS:

The segment of the study presents the discussions on the analysis of the various transposed linear equations that showed significant difference as well as those that do not show significant departures from earlier linear ones. See tables (4.3 & 4.4) as well as (2, 3, 4) and Appendix 1 earlier referred to.

The outcome of very significant number of the linear relationships between and amongst the variables using both simple and multiple regression did not establish significant relationships. In

view of the above observations, the research embarked on further probe beyond the established linear model, this involved the following: The transpositions of the initial linear relationships and the variables to their polynomial and exponential equivalents. Undertaking the transpositions derived its premise from observations that the goodness of fit of the linear equations did not establish any significant relationships between and amongst variables.

DISCUSSIONS ON THE RESULTS OF THE TRANSPOSITIONS ON LINEAR REGRESSION EQUATION

This is expressed as a percentage of the outcome of the simple correlation between budgetary allocations as well as budgetary allocations to the housing sector and the prices of building materials.

The segment of discussion is focused on the outcome of the results of the transpositions undertaken on the various established relationships derived from the initial linear regression models. The study uses the statistical technique of percentile in ascertaining which of the transposed initial linear regression equations gave rise to differentials in the format as well as status of the initial linear regression equations:

1. *Outcome of the transposed simple correlation Analysis between Budgetary Parameters (see tables 4.3 & 4.4) for inferences from (the study of Mac-Barango and Mbamali 2015).* A total of 12 (twelve) equations were studied, having the following number formats and status 4(four), 4(four) and 4 (four) for linear, quadratic and cubic models respectively. All the 12 (twelve) relationships, did not show any significant relationships. The transpositions undertaken on linear models represent a 100% non-differential and did not show any significant differences between the initial linear and the transposed ones.
2. *Outcome of the transposed simple correlation analysis between budgetary parameters and the prices of building materials for inferences.* (See table 2, 3 & 4) under the study of Mac-Barango & Shittu 2015). A total of 21 (twenty one), equations were studied under this category. The statistical technique of percentile was also employed as the basis towards drawing of inference to evaluate which of the transposed linear equations gave rise to differences in status as well as formats. The outcome of the transpositions undertaken irrespective of the % changes in prices of building materials to housing sector did not also show significant departures from the initial linear ones.

IMPLICATIONS OF THE RESULTS OF THE TRANSPOSITIONS:

The occurrence of the above observed outcome of transpositions would appear to question the essence of undertaking transpositions of linear regression models, particularly as they concern the analyzed parameters used towards the establishment of the initial linear regression equations. i.e. budgetary allocations, versus demographics as well as the prices of building materials.

CONCLUSION AND RECOMMENDATION:

The research drawing from the empirical analysis from previous works as well as literature reviews concludes as follows: Transpositions of models are statistical operations usually undertaken to ascertain if linear models developed from regression analysis could possibly lead to other formats of non-linear models that are potently efficient to perform predictive functions. Considerably number of transpositions undertaken did not show significant departures from the initial linear models established. The essence of transpositions based on the research is questionable as such further probe into the subject area is inevitable.

The research based on the prevailing circumstance and scenario seeks to recommend what needs to be done to unravel the essence of undertaking transpositions of linear models. The research recommends that it would be appropriate to undertake transpositions of linear models with other parameters besides the ones involved in this research. The study in essence, serves as an exploratory basis that ventures into the subject area, ascertaining if transpositions could lead to other nonlinear regression models.

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Appendix 1: Result of Simple Correlation Analysis between Budgetary and Demographic Parameters

Variables			Type	Observations					Inferences		
A na No	X	Y	of Mode1	Regression Equation	R ²	F _{cal}	F _{ta} b	P _{value}	Strengt h of Relatio nship	Rm k	Action on hyp
7a	Total student Popnn	Total State Budget	Linear	Total State Budget = 294698.8-0.863	41. 9%	4.3 32	5.9 9	0.083	Very weak	NS	Accept H ₀
7b			Quadra tic	Total Student Popn Total State Budget = 460045.4-2.6864	43. 0%	1.8 85	5.7 9	0.245	Very weak	NS	Accept H ₀
8a	Total student Popnn	Total State Budget	Linear	Total Student Popn x 4.64 x10 ⁶ Total Student Popn2 State Capital Budget = 229837.3-0.700	45. 2%	4.9 50	5.9 9	0.068	Very weak	NS	Accept H ₀
8b			Quadra tic	Total Student Popn Total Student Popn + 4.77 x 10-6 Total Student Popn2 State Capital Budget = 400026.0-2.576	47. 0%	2.2 21	5.7 9	0.204	Very weak	NS	Accept H ₀