RIVERS STATE UNIVERSITY, PORT HARCOURT

"STATISTICS: THE MOST USED AND THE MOST ABUSED SUBJECT"

AN INAUGURAL LECTURE

By

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B.Sc. (1st Class Honours), M.Sc., PhD (Statistics) Ibadan

Professor of Applied Statistics

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38. Etuk, E. H. and Victor-Edema, U. A. (2017). Box-Tiao Intervention Modelling of Monthly EUR-NGN Exchange Rates due to Nigerian Economic recession. Journal of Scientific and Engineering Research, 4(3): 59-65.

39. Etuk, E., Agbam, A. and Moffat, I. (2017c). Interrupted Time Series Analysis of Nigerian Monthly Distribution of Petroleum Products. World Wide Journal of Multidisciplinary Research and Development, 3(7): 108-113.

40. Etuk, E. H., Igbudu, R. C. and Wegbom, A. I. (2017d). Interrupted Time Series Analysis of Daily Amounts of Nigerian Naira Per Ugandan Shilling.Journal of Scientific and Engineerinng Research, 4(6): 170-175.

41. Etuk, E. H., Dimkpa, Y. M. and Sibeate, P. (2017e). ARIMA Intervention Modelling of Monthly GBP-NGN Exchange Rates. CARD International Journal of Science and Advanced Innovation Research, 2(1): 1-13.

42. Feller, W. (1957). An Introduction to Probability Theory and its Applications, Third Edition, Volume 1, John Wiley & Sons, Inc.

43. Garfield, J. (2002). The Challenge of Developing Statistical Reasoning. Journal of Statistical Education, 10(3) www2.amstat.org/publications/jse/v10n3/ garfield.html

44. Marson, J. L. (2006). An Enemy Called Average. WordAlive Publishers.

45. Rumsey, D. J. (2002). Statistical Literacy as a Goal for Introductory Statistics Courses. Journal of Statistics Education(online),10(3). www.amstat.org/publications/ jse/v10n3/ rumsey3. html

46. Walpole, R. (1974). Introduction to Statistics, Second Edition, Macmillan publishing Co., inc., New York.

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35. Etuk, E. H. and Eleki, A. G. (2017). Arima Intervention Analysis of Monthly Xaf-Ngn Exchange Rates Occasioned By Nigerian Economic Recession. Noble International Journal of Economics and Financial Research, 2(4): 76-81.

36. Etuk, E. H., Dimkpa, Y. M., Sibeate, P. and Godwin, N. (2017). Intervention analysis of daily Yen/Naira Exchange Rates. Management and Administrative Science Review, 6(1): 41-49.

37. Etuk, E. H., Ngerebo-a, T. and Uzah, C. K. (2017b). Box-Tiao Interrupted Time Series Analysis of Bureau de Change USD/NGN Exchange Rates. International Journals of Advanced Research in Computer Science and Software Engineering, 7(6): 50-54.

24. Etuk, E. H., Amadi, U. I., Dimkpa, M. Y., Aboko, I. S. and Igbudu, R. C. (2014). Modelling of Rivers State Monthly Allocation by Seasonal Box-Jenkins Methods. Journal of Physical and Innovation, Vol. 6, No. 2, pp. 33 – 40.

25. Etuk, E. H. and Ojekudo, N. (2015). Subset SARIMA modelling: An alternative definition and a case study. British Journal of Mathematics and Computer Science. Vol. 5, No. 4, pp. 538 – 552.

26. Etuk, E. H. and Natamba, B. (2015). Daily Uganda Shilling/United States dollar Exchange Rates Modeling by Box-Jenkins Techniques. International Journal of Management, Accounting and Economics, Vol. 2, No. 4, pp. 339-345.

27. Etuk, E. H. and Natamba, B. (2015). Modelling Monthly Ugandan Shilling/US Dollar Exchange Rates by Seasonal Box-Jenkins Techniques. International Journal of Life Science and Engineering, Vol. 1, No. 4, pp. 165 – 170.

28. Mohamed, T. M. and Etuk, E. H. (2016). Simulation of Monthly Flow for the Dinder River, Sudan. Journal of Basic and Applied Research International, Vol. 14, No. 4: 265 – 271.

29. Etuk, E. H. (2016). A novel algorithm for sarima model fitting: modeling pound-euro exchange rates as case study. Journal of Scientific and Engineering Research, 3(6): 378-386.

30. Etuk, E. H. (2016). Daily Chinese Yuan – Nigerian Naira Exchange Rates SARIMA Modelling. Journal of Physical Science and Innovation, 8(1): 57- 68.

The Vice-Chancellor
The Deputy Vice Chancellor
Registrar and other Principal Officers of the University
Distinguished Professors and Eminent Scholars
Members of Governing Council here present
Members of Senate
Distinguished Guests, Friends and family members
Staff and Students of Rivers State University
Ladies and Gentlemen

1. PREAMBLE

Vice Chancellor Sir, my motto is: "Whatever your hand finds to do, do it with all your might, for there is no work, nor device, nor knowledge, nor wisdom, in the grave where you are going," Ecclesiastes 9:10-Today is a landmark in my life as an academic. To all be the glory; great things He has done. I decided to speak on this topic because of its simplicity and obviousness. As a Professor of Applied Statistics I see it as a duty to share with us on this occasion on the topic **Statistics, the most used and the most abused subject** because of the ubiquity of the applications of statistics and its importance in national and international development. Besides, it is my hope to be easily understood by my audience. Do not misunderstand me, I believe that every discipline is indispensable in its own

right. For instance, the discipline of History which seems to be facing the threat of extinction is indispensable because history must repeat itself. There is nothing new under the sun. Without fear of contradiction I say that Mathematics being the language of science is very powerful and has a wide coverage. Its elegance and beauty is comparable to none else. Mastery of Mathematics though hard gives (or is supposed to give advantage over other subjects. Learning of Mathematics calls for hard work and concentration. Surprisingly we notice that often students who are rejected as unqualified in other departments are sent to study mathematics as a last resort. No wonder such students are eventually weeded out of the system. Mathematics is a calling just as Medicine or Accountancy or even Policing.

I have respect for every discipline. No discipline knows it all. I respect in particular Chemistry scholars because much as I put in effort to pass the subject in my A-levels at Federal Government College, Ikot Ekpene in 1976, I got an O (i.e. equivalent to O level). Nothing dazes me more than organic Chemistry symbols and patterns. I wonder how they are understood. Next is Physics. With all the efforts I put for it I had an E. I put the least effort in Mathematics, yet I got an A. The global trend is to adopt a multidisciplinary approach in proffering solution to research problems. No discipline should be despised. I happen to be actively involved on a yearly basis in the holding of Interdisciplinary Conference under the umbrella of Centre for Promotion of Educational and Scientific Research (CPESR) whose headquarters is at Minna.

17. Etuk, E. H. (2013). Multiplicative Sarima Modelling of Daily Naira-Euro Exchange Rates. International Journal of Mathematics and Statistics Studies. Volume 1, No. 3, pp. 1-8.

18. Etuk, E. H. and Igbudu, R. C. (2013). A Sarima Fit to Monthly Nigerian Naira-British Pound Exchange Rates. Journal of Computations & Modelling, Vol. 3, No. 1, pp. 133 – 144.

19. Etuk, E. H. and Mohamed, T.M. (2014). Time Series Analysis of Monthly Rainfall Data for the Gadaref rainfall station, Sudan, by Sarima methods, International Journal of Scientific Research in Knowledge, Vol. 2, No. 7, pp. 320 – 327.

20. Etuk, E. H., Amadi, I. U., Aboko, I. S., Dimkpa, M. Y. and Igbudu, R. C. (2014). Application of Seasonal Box-Jenkins Techniques for Modelling Monthly Internally Generated Revenue of Rivers State of Nigeria. International Journal of Innovative Science, Engineering & Technology, Vol. 1, Issue 7, pp. 122 – 126.

21. Etuk, E. H and Mohamed, T. M. (2014). A Seasonal Arima Model for Forecasting Monthly Rainfall in Gezira Scheme, Sudan. Journal of Advanced Studies in Agricultural, Biological and Environmental Sciences. Vol. 1, No. 1, pp. 1 – 9.

22. Etuk, E. H., Agbam, A. S., Sibeate, P. U. and Etuk, F. E. (2014). Another Look at the Time Series Modelling of Monthly Internally Generated Revenue of Mbaitoli LGA of Nigeria. International Journal of Management Sciences, Vol., No. 11, pp. 838 – 846.

23. Etuk, E. H. and Amadi, E. H. (2014). A Model for the forecasting of Daily South African Rand and Nigerian Naira Exchange Rates. International Journal of Modern Sciences and Engineering Technology, Vol. 1, Issue 6, pp. 89 – 97.

9. Etuk, E. H. (2012). A Multiplicative Seasonal Box-Jenkins Model to Nigerian Stock Prices. Interdisciplinary Journal of Research in Business. Vol. 2, No. 4, pp. 1-7. (BRITAIN)

10. Etuk, E. H., Uchendu, B. and VictorEdema, U. A. (2012). Forecasting Nigerian Inflation rates by a Seasonal Model.. Canadian Journal of Pure and Applied Sciences. Vol. 6, No. 3, pp. 2179-2185.

11. Etuk, E. H., Asuquo, A. and Essi, I. D. (2012). A Seasonal Box-Jenkins Model for Nigerian Inflation Rate Series. Journal of Mathematical Research. Vol. 4, no. 4,pp. 107-113.(CANADA)

12. Etuk, E. H. and Iwok, I. A. (2012). Zero-Lag White Noise Vector Bilinear Autoregressive Time Series Models. American Journal of Scientific and Industrial Research. Vool. 3, No. 2, pp. 86-93.

13. Etuk, E. H., Elenga, B. N. And Maxwell, A. A. (2012). Application of Knapsack Problem to the Budgetary Allocation of Seven Ministries in Rivers State of Nigeria. Journal of the Common Wealth Research and Capacity Education Initiative (CWRCEI), Volume 3, pp. 95 – 104.

14. Etuk, E. H. (2013). The Fitting of a Sarima Model to Monthly Naira-Euro Exchange Rates. Mathematical theory and Modelling. Volume 3, No. 1, pp. 17-26. (MEXICO)

15. Etuk, E. H. and Amadi, E. H. (2013). Multiplicative Sarima Modelling Of Nigerian Monthly Crude Oil Domestic Production. Journal of Applied Mathematics & Bioinformatics. Volume 3, No. 3, 103 – 112.

16. Etuk, E. H. (2013). Seasonal ARIMA Modelling of Nigerian Monthly Crude Oil Prices. Asian Economic and Financial Review. Volume 3, No. 3, pp. 333 – 340.

A Professor and a former Dean of Science told me that we Mathematics lecturers parade ourselves as superior to others. This is false and nothing can be further from the truth. It is said out of envy and malice. It is no wonder that Department of Mathematics is persecuted at the slightest opportunity. How else do you explain why non-members are often drafted to head the department? Yet history is replete with cases of Mathematician administrators. For instance, Professor Oyewusi Ibidapo-Obe was the Vice-Chancellor of University of Lagos and Professor Mrs Grace Alele-Williams was the Vice-Chancellor of the University of Benin both for years and they are Mathematicians. We should be allowed to run our affairs as a department.

After my A levels in 1976, I was given appointment as an auxiliary teacher and I taught Mathematics at Nigerian Christian Secondary School, Ukpom, Abak with an Indian, Alexander Mathai. He had M.Sc. in Statistics. I derived inspiration from him to read Statistics in my B.Sc., M.Sc. and Ph.D.

The word "Statistics" was coined out the word "State" because it was to be applied to analyze matters of the State or Nation. Statistics is applicable in all of Science as a tool of Scientific Inquiry. In scientific research statistics enters at the point of data collection, collation and analysis. In all spheres of human endeavour, statistics is indispensable. The generalization that comes with statistical inference makes it highly applicable, everywhere and every time.

2. INTRODUCTION

Mathematics is undoubtedly the language of science. Statistics is a mathematical science because it uses mathematics as a language. Often they are together as a joint department as here, in University of Port Harcourt and in University of Uyo. The current trend is for them to operate as separate departments. Mathematics is based on deductive inference, i.e. argument from the whole to the part, whereas statistics is based on inductive inference, that is, argument from the part to the whole. Whereas deductive inference is certain, inductive inference is uncertain or probabilistic. The certainty of deductive reasoning is what makes mathematics a very powerful language of science. There is Mathematical Statistics which borders on Probability. There is also Statistical Mathematics. There is an Institute of Mathematical Statistics in Bethesda, U. S. A. and an Institute of Statistical Mathematics in Tokyo, Japan, whose focus is to advance the discipline and study of Statistics. It is observed that Statistical Mathematics and Mathematical Statistics are used interchangeably. Vice Chancellor Sir, permit me to use this opportunity to ask for the establishment of a Department of Statistics here separate from the Department of Mathematics as in other places, as global trends demand, even as stipulated by the NUC.

16. REFERENCES

1. Box, G. E. P. and Tiao, G. C. (1975). Intervention analysis with applications to Economic and Environmental Problems. Journal of American Statistical Association, 70(349): 70-79.
2. Chance, B. L. (2002). Components of Statistical Thinking and Implications for Instruction and Assessment. Journal of Statistical Education, 10(3), ww2.amstat.org/publications/jse/v10n3/chance.html
3. Etuk, E. H. (1988). On Autoregressive Model Identification. Journal of Official Statistics, 4(2), 113 – 124.
4. Etuk, E. H. (1996a). A Note on Akaike's Information Criterion (AIC) and Bayesian Information Criterion (BIC). Journal of Agriculture, Science and Technology, 3(2), 158 – 161.
5. Etuk, E. H. (1996b). "An Autoregressive Integrated Moving Average (ARIMA) Simulation Model: A Case Study." Discovery and Innovation. Vol. 10, Nos. 1 & 2, pp. 23 – 26.(KENYA)
6. Etuk, E. H. and Mbegbu, J. I. (2007). Formulation of MV-optimal balanced incomplete block (BIBD) designs with cost constraint. Jour. Of Inst. Of Math. & Comp. Sci., Vol. 20, No. 3, pp. 213 – 218.(INDIA)
7. Etuk, E. H., Uchendu, B. A. and Victor-Edema, U. (2012). Arima Fit to Nigerian Unemployment Data. Journal of Basic and Applied Scientific Research, Vol. 2, No. 6, pp. 5964 – 5970.(SAUDI ARABIA)
8. Etuk, E. H. (2012). Seasonal Arima Model to Nigerian Consumer Price Index Data. American Journal of Scientific and Industrial Research, Vol. 3, no. 5, pp. 283 – 287.

still have very intimidating credentials. However when I applied to this University I was given the job even without an interview. I believe that I have justified the confidence reposed on me by this University. Thank you very much.

Statistics as a Discipline

As a discipline, statistics concerns itself with methods of data collection, collation and analysis with the purpose of making inferences on the underlying population. Hence, statistical inference is inductive in nature. As a tool of scientific inquiry, the major purpose of statistics is to facilitate discovering the truth about the world.

Statistics as a Profession

Statistics is a profession. The training of statisticians endows upon them special skills of data analysis, interpretation and mentality to cope with the demands of their job.

There are practicing statisticians in the industries, in research institutes, in the banking industries, in the medical institutions, in the academia and in all types of institutions. However there is nothing esoteric about the body of knowledge required for the practice of statistics in the same way there is in law or medicine. Statistical associations including the Nigerian Statistical Association have been considering the possibility of making the discipline a profession.

The work of a statistician does not involve only data analysis. He may have to design responses, design studies, experiments and surveys, help people to relate data analysis to the aims of study and interpret results of analysis of data. The fields of employment are endless; the manufacturing sector, medical institutions, government, the business sector, the academia, and so on, often require the services of statisticians.

3. STATISTICAL SCHOOLS OF THOUGHT

Statistics is all about making inference on the population of interest on the basis of sample information and characteristic. There are basically two approaches to statistical inference.

The Frequentist Approach to Statistics

The frequentist approach involves regarding the population characteristic or parameter as constant. That is, it is not a random variable and therefore has no probability distribution.

The Bayesian Approach To Statistics

On the other hand some statisticians believe that a population parameter could be handled as a random variable in which case it has a probability distribution referred to as the *prior distribution.* With the available data this distribution is updated to yield a *posterior distribution.* This provides basis for statistical inference. None of the approaches is consistently better than the other.

My Ph. D thesis involved a new Autoregressive Moving Average Fitting Algorithm. There were obvious limitations which included possible negative variance estimates. On the day of my defence Professor Biyi Afonja a Fellow of the Nigerian Statistical Association suggested that a Bayesian approach be adopted to remedy the situation. To the best of my knowledge that still remains an unsolved research problem.

The professors of the Faculty of Law include U Jack-Osimiri, N S Okogbule and D V C Okene. I thank them too.

The professors of the Faculty of Technical and Science Education are G I K Akaniwor, A M Wokocha, W A Amaewhule, M I Ahiakwo, M N Koko and J Vipene. I owe them thanks too. Professors D M J Fubara (Emeritus) and O B Owei of the Environmental Sciences Faculty also deserve my thanks.

I thank my students also. If they were not available I would not be what I am today. In teaching others we also learn. The average student wants to be over-familiar with the lecturers.

I thank my nuclear family; my better-half, Felicia, and two children, Imekan aged 26 and Harrison 20, who have the same birthday 8th April. The girl was born on 8th April, 1991 and the boy on 8th April 1997. The degree of rarity of this event is better appreciated by discussing its probability. According to Feller (1957:33) the probability is 0.0027 for two persons to have the same birthday. This probability would even be smaller if the said persons are to come from the same parents. Our family should be in the Guinness Book of Records for having children having the same birthday, though not twins. God, indeed, works in mysterious ways His wonders to perform.

Finally I thank the Rivers State people. They have been indeed hospitable and friendly. Prior to coming to this University I have been invited for an appointment interview in a University but was blocked from facing the interview panel because I had and

technical, but one that the expected audience of the University community would easily follow. I thank also the following colleagues from the Department of Computer Science: Squadron Leader S U Chindah, V I E Anire, Dr N Nwiabu, Mr O E Taylor, Dr D. Mathias, Dr E O Bennett, Mr V Emmah, Mr F Orji, Mr C. Igiri, Mr E Thomas and Miss F Deedam.

An inaugural lecture is a professorial occasion. The Professors of the faculty of Science deserve special thanks: Godwin N. Isitor, E N Amadi, E R Amakorome, J A Onwugbuta-enyi, O. Obire, T G Sokari, C Israel-Cookey, E E Orlu, F B Sigalo, C K Wachukwu, I K E Ekweozor, E D Uko, I R Jack, E Chuku, E Wachukwu, I F Oruambo, B O Green,S. C. Teme, C Obunwo and O C Umeozor.

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4. TEACHING AND LEARNING STATISTICS AS A DISCIPLINE

Statistical education is targeted at three levels of statistical development, namely, statistical literacy, reasoning and thinking.

Statistical Literacy is the ability to understand and use statistical terminologies and notations. A pre-requisite to this is numeracy and rudimentary knowledge of probability. Statistical results are communicated on a daily basis by the magazines, newspapers and televisions. Statistical literacy is the ability to interpret statistical statements and results appropriately. This is bound to reduce incidence of abuse of statistics in the society (Rumsey, 2002).

Statistical Reasoning is the ability to make sense of statistical data and analysis. With it connection between concepts and results can be made. It involves being able to interpret statistical processes and outcomes (Garfield, 2002).

Statistical Thinking involves knowledge of the why and how statistical analyses are done, why and how the techniques are used and why and how the final inferences are made. Thinking leads to data exploration beyond the textbook knowledge, posing new questions and devising new approaches to data analysis (Chance, 2002).

5. IS AVERAGE NECESSARILY AN ENEMY?

Mason (2006) counsels on the need to avoid mediocrity. To him mediocrity is average ability and this informs the title of his book **An Enemy Called Average.** I agree with him that mediocrity is to be avoided by hard work, determination and faith in God.

However I believe that mediocrity is not average ability but less than average ability. The word average is a statistical term referring to a measure of central tendency or a measure of location. It is a number which can be used as representative of the set of data.

Average is therefore not an enemy. Rather being below **average** is to be avoided. Being above average always attracts envy and enmity. Being average is the most desirable. In the book of Proverbs 30:8-9, the Bible declares

Remove far from me vanity and lies: give me neither poverty nor riches; feed me with food convenient for me: Lest I be full and deny thee, and say, Who is the Lord? Or lest I be poor, and steal, and take the name of my God in vain.

Therefore **average** is not an enemy but a friend.

6. DISPERSION MINIMIZATION GOAL :

Statisticians are interested in measures of location as well as of dispersion for a particular set of data. Measures of location are about the commonality tendencies of the sample elements. On the other hand, the measures of dispersion are about the variability tendencies of the sample items. Minimization of

faced in life the enemy has not really prevailed over me. My late mother used to relate to us the circumstances that led to the change of my name.

I use this opportunity to also show appreciation to the Management of this University ably headed by the Vice-Chancellor, Professor Blessing C. Didia, for this opportunity and privilege given me to give this inaugural lecture. It is a great honour given to me. I am a prolific academic today because of the conducive atmosphere I am enjoying here to be able to publish so profusely. I am thankful to the members of Senate for supporting and inspiring me one way or another. I thank Professor Adolphus Toby for inviting me to be involved in teaching and research in his department. I thank Dr Mrs Gloria Wokem for giving me the honour to teach Postgraduate students in her department.

I thank my departmental colleagues, Dr Emeka Amos, the Acting Head of Department, Professor Isaac Essi, Dr Enu-Obari Ekaka-a, Dr Ngia Nafo, Dr Iyai Davies, Mr Eberechi Amadi, Mr Azubuike Weli, Mr Liberty Ebawereme, Mrs Ndu and Mr Richard Akpodee. They have contributed in one way or the other to make this occasion a huge success. Mostly I am indebted to Dr Ekaka-a, who, as soon as my Professorship was announced kept on reminding to start writing my inaugural lecture. Also worthy of mention are the office staff J.B. Barivole, K. Theophilus and Hope Anucha. One of the most daunting tasks I have undertaken is choosing an appropriate topic to write on for this inaugural lecture - a subject not too

the major statistical agencies should be established. Duplication of irreconciliable data should be minimized.

Modern techniques bordering on computer data bases should be employed for the forthcoming census 2018. This will go a long way to better the census exercise and results.

The Central Bank of Nigeria has embarked on intervention measures of injecting US dollars into the foreign exchange market to salvage the value of the Naira. The impact is not likely to be permanent unless these measures are sustained. More permanent impact may be obtained by the application of some of these intervention models discussed within this booklet.

15. ACKNOWLEDGMENT

Mostly I thank the God of Abraham, Isaac and Jacob, and my God, for granting me good success in my career from the very beginning up to this day. It is indeed His doing and it is marvelous in our eyes. I cannot thank Him enough. In fact, it is not of him that willeth nor of him that runneth but of God that showeth mercy. The horse may be prepared for the battle but "safety is of the Lord". I thank my late parents Mr and Mrs Harrison Umo Etuk and my late senior brother Ubokobong Harrison Etuk for sacrificing so much to educate me to make me what I am today. My father was so statistically minded that he used to keep diaries on a daily basis. From his records I learnt that I was born on 25th March 1957 and also that the first name I was given was Usuaikanke meaning "the enemy has not prevailed over us". No wonder that upon all the trials I have

measures of dispersion is a goal. For instance comparison of two estimators is often on the basis of their mean square error or variance or standard error, which are all measures of dispersion. The estimator which has the lesser measure is adjudged as the more adequate.

There is a clamour for an egalitarian society where class differences are brought to a minimum. This may be why there are uniform attire among pupils, students and para-military personnel. The use of *aso ebi* especially by the womenfolk for special occasions may also be for egalitarian purpose.

A four-year Bachelor of Science (B. Sc.) programme in Statistics will involve in the first two years basic mathematics, statistics and computer science courses. In the University of Ibadan, in the first two years all Mathematics, Statistics and Computer Science students offer the same courses. In the last two years, the students move to their different areas of specializations. This prepares the statistics students for challenges of modern civilization.

7. RESEARCH QUESTIONS

The world is full of unsolved research problems. With statistical reasoning and thinking research questions of the types listed below may be posed. Some of these problems may have been answered earlier but research is never exhausted:

- ❖ Why are Kenyans so good at long distance races?
- ❖ Why are South Americans so good at soccer?

- Why are the Williams sisters, Venus and Serena, such good tennis players, with Venus at 37 still qualifying for the last Wimbeldon tournament finals?
- Why is the North East of Nigeria the hub of insurgency in the country to the extent that school girls totaling more than 200 could be kidnapped together and up till now not all have been rescued?
- Why is the village Nto Edet in Etim Ekpo Local Government Area of Akwa Ibom State famous as bone setters?
- Why are Ikot Ekpene indigenes so good at raffia and sculpture making?
- How is Brexit going to affect the British?
- An Iranian is a Lionel Messi look-alike. Could they have a common ancestry?
- A couple in my neighbourhood look alike. Are the having the same ancestry?
- Why do the Japanese look alike?
- Why are the Eskimos dwarfs?
- How true could the evolution story be?
- What is the impact of the economic recession in Nigeria on its citizenry and what intervention measures can be put in place to salvage the situation?
- In the last FIFA world cup in Brazil, what probability distribution could be associated with the frequency distribution of goals scored?

14. RECOMMENDATIONS

Vice Chancellor Sir, firstly I recommend that a Department of Statistics be created for this University. It is long overdue. The Department of Statistics of the University of Ibadan from which I graduated was created with two pioneer lecturers Late Professor S. O. Adamu and Mrs T. L. Johnson. I believe that we have enough staff strength to start a Department of Statistics. However, if it is perceived that a full-fledged Department is infeasible at least a B.Sc. programme domiciled in the Department should be mounted.

The study of Mathematics should be encouraged. Excellent performance in Mathematics should be rewarded. Effort of Promasidor Nigeria and the National Examination Council NECO to be organizing Cowbellpedia National Mathematics Competition is commendable. Government should employ more Mathematics/ Statistics lecturers to be able to service some other departments adequately.

Effort should be made to make the Nigerian populace more statistically literate. There was a time when the subject of Statistics was offered in the West African School Certificate Examinations. Currently it has been removed and it should be included again.

The 2007 Statistical Act should be enforced. Any non-compliance should be duly punished to act as a deterrent. Availability of accurate data is necessary for the development of this country. A body to coordinate data collection activities of

25. Arima Intervention Analysis of Monthly XAF-NGN Exchange Rates Occasioned by Nigerian Economic Recession (Etuk and Eleki, 2017)

$$Y_t = \frac{\varepsilon_t}{\nabla} + 0.6574(1 - 0.4571^{t-149}), I_t = 0, t < 150, I_t = 1, t > 149$$

26. Interrupted Time Series Analysis of Nigerian Monthly Distribution of Petroleum Products (Etuk et al. 2017c)

$$Y_t = \frac{\varepsilon_t}{(1+0.5823L+0.4117L^2)\nabla} + \frac{1056567 I_t * (1 - 0.1494^{t-48})}{0.8506}$$

where $I_t = 0$, $t < 49$, $I_t = 1$, otherwise.

27. Interrupted Time Series Analysis of Daily Amounts of Nigeria Naira Per Ugandan Shilling (Etuk *et al.,* 2017d)

$$Y_t = \frac{\varepsilon_t}{\nabla} + \frac{0.004080 * (1 - 0.874601^{t-33}) I_t}{(1 - 0.874601)}$$

where $I_t = 1$, $t \geq 34$ and zero elsewhere.

28. ARIMA intervention modeling of monthly GBP-NGN Exchange Rates(Etuk *et al,* 2017e)

$$Y_t = \frac{(1-0.8685L^{18})\varepsilon_t}{(1-L)(1-0.7775L^{18})} + \frac{1.0492 * I_{t*}(1 - 1.1292^{(t-188)})}{(-0.129319)}$$

where $I_t = 1$ after March 2015 and zero before March 2015.

❖ What are possible forecasts of Nigerian external reserves up to 2017?

In other words, statistical training should not only sharpen one's curiosity but also equip one to provide answers to the questions so raised. Statistical knowledge is needed for the modeling and interpretation of the multifarious phenomena and their connections. On this lies the **philosophy of statistics.**

I hereby provide solutions to the last but one research question. As a soccer enthusiast I have been wondering what probability distribution the number of goals scored in the last FIFA World Cup of June 13 to July 13, 2014 in Brazil, at group stage would have. I am, moreso, interested because of Nigerian participation in the tournament. Below are the results:

Group A

Brazil	-	Croatia	3 - 1
Mexico	-	Cameroun	1 - 0
Brazil	-	Mexico	0 - 0
Cameroun	-	Croatia	0 - 4
Cameroun	-	Brazil	1 - 4
Croatia	-	Mexico	1 - 3

Group B

Spain	-	Holland	1 - 5
Chile	-	Australia	3 - 1
Australia	-	Holland	2 - 3
Spain	-	Chile	0 - 2
Australia	-	Spain	0 - 3
Holland	-	Chile	2 - 0

Group C

Colombia	-	Greece	3 - 0
Cote dÍvoire	-	Japan	2 - 1
Colombia	-	Cote dÍvoire	2 - 1
Japan	-	Greece	0 - 0
Japan	-	Colombia	1 - 4
Greece	-	Cote dÍvoire	2 - 1

Group D

Uruguay	-	Costa Rica	1 - 3
England	-	Italy	1 - 2
Uruguay	-	England	2 - 1
Italy	-	Costa Rica	0 - 1
Italy	-	Costa Rica	0 - 1
Italy	-	Uruguay	0 - 1
Costa Rice	-	England	0 - 0

Group E

Switzerland	-	Ecuador	2 - 1
France	-	Honduras	3 - 0
Switzerland	-	France	2 - 5
Honduras	-	Ecuador	1 - 2
Honduras	-	Switzerland	0 - 3
Ecuador	-	France	0 - 0

21. Intervention analysis of Daily Yuan-Naira Exchange Rates (Etuk and Eleki, 2016).

$$Y_t = \frac{(1-.4415L^2)\,\varepsilon_t}{(1-L)} + I_t \frac{1.7172(1-0.8970^{t+1})}{(1-0.8970)}$$

where I_t =0, t < 52, I_t =1, t ≥ 52 where L=1-∇.

22. Intervention analysis of Daily Yen-Naira Exchange Rates (Etuk *et al.,* 2017a).

$$Y_t = \frac{\varepsilon_t}{(1-L)(1-0.321034L^{18})} + 0.0973I_t \frac{(1-.9102^{(t-50)})}{(1-.9102)}$$

where I_t =0, t < 52, I_t =1, t ≥ 52 where L = 1-∇.

23. Box-Tiao Intervention analysis of Monthly EUR-NGN exchange rates occasioned by Nigerian economic recession (Etuk and Victor-Edema, 2017)

$$Y_t = \frac{(1+0.4972L^{11})\varepsilon_t}{(1-0.6784L^{11})\nabla} + I_t \frac{44.4282*(1-0.6252)^{(t-148)}}{(1-0.6252)}$$

where I_t =1, t>149; zero elsewhere.

24. Box-Tiao Interrupted Time Series Analysis of Bureau De Change USD/NGN exchange Rates (Etuk et al., 2017b)

$$Y_t = \frac{\varepsilon_t}{(1-.5772L+.2119L^2-.1908L^3+.2179L^4-.1892L^5+.2956L^6)\nabla} - 65.7712*(1-1.0708^{t-132})I_t$$

,I_t = 1, t > 132, equal to zero, otherwise where L = 1 - ∇

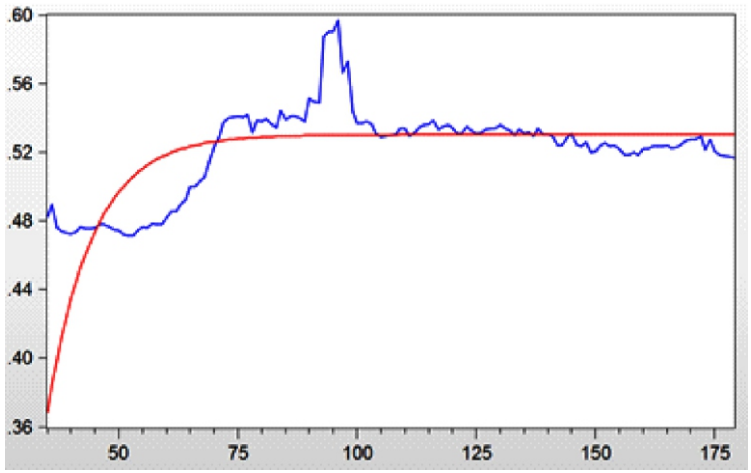


Figure 9: Post-intervention rates and their forecasts

The crisis of economic recession in Nigeria has necessitated intervention in all sectors of the economy. The above discussed XOF/NGN case is an example. XOF is the West African currency and it is better off than the NGN. The relative abysmal performance of the NGN calls for intervention. The model (4) is proposed for that purpose. Other intervention models that I have proposed are the following:

20) Intervention analysis of Daily GBP-USD Exchange Rates occasioned by BREXIT

$$GBUS_t = \frac{\varepsilon_t}{(1-0.2024L)(1-L)} - 0.1770I_t\,(1 - 0.6412_{t+1})$$

where $I_t = 0, t < 100, I_t = 1, t \geq 100$ where $L=1-\nabla$

(Etuk and Amadi, 2016)

Group F

Argentina	-	Bosnia-Herzegovina	2 - 1
Iran	-	Nigeria	0 - 0
Argentina	-	Iran	1 - 0
Nigeria	-	Bosnia-Herzegovina	1 - 0
Nigeria	-	Argentina	2 - 3
Bosnia - Herzegovina		-Iran	3 - 1

Group G

Germany	-	Portugal	4 - 0
Ghana	-	USA	1 - 2
Germany	-	Ghana	2 - 2
USA	-	Portugal	2 - 2
USA	-	Germany	0 - 1
Portugal	-	Ghana	2 - 1

Group H

Belgium	-	Algeria	2 - 1
Russia	-	South Korea	1 - 1
Belgium	-	Russia	1 - 0
South Korea	-	Algeria	2 - 4
South Korea	-	Belgium	0 - 1
Algeria	-	Russia	1 - 1

Figure 1: *Results of Round One matches of Brazil 2014 FIFA World Cup*

Source: https://www.fifa.com accessed 4th August 2017

Table 1: Frequency Distribution of the number of goals scored in the group stage of Brazil 2014 FIFA World Cup

Number of goals scored	frequency	Expected frequency under Poisson distribution
0	26	23.28
1	31	32.98
2	21	23.36
3	11	11.03
4	5	3.91
5	2	1.44

The mean is 1.4167 and the variance is 13.0876. With a high probability of zero score and positive skewness, I hypothesize a Poisson distribution fit.

The chi-square goodness-of-fit statistic is equal to

$$\frac{(26-23.28)^2}{23.28}+\frac{(31-32.98)^2}{32.98}+\frac{(21-23.36)^2}{23.36}+\frac{(11-11.03)^2}{11.03}+\frac{(7-5.35)^2}{5.35}=1.1841$$

which, with a p-value of more than 0.70, is not significant. Therefore the number of goals scored in the last FIFA World Cup in which Nigeria participated followed a Poisson process.

The last question on Nigerian external reserves shall be addressed later under my contributions to knowledge.

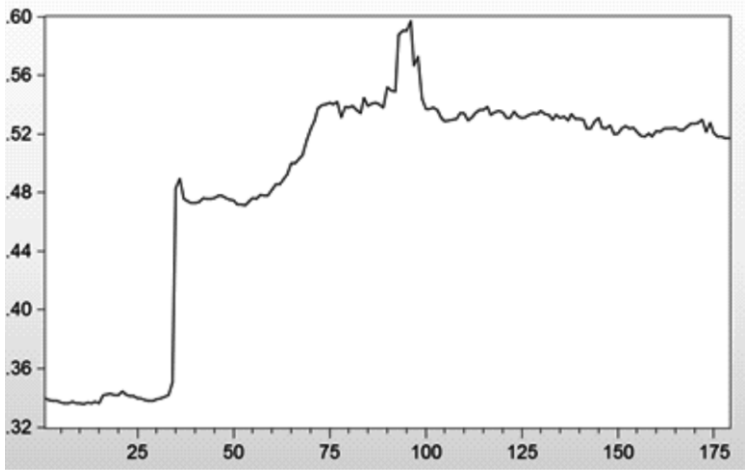


Figure 8: The Amount of Naira per XOF

The intervention model is given by

$$Y_t=\frac{\varepsilon_t}{1-L}+\frac{0.017929(1-0.900182^{t-84})}{(1-0.900182)},\ t\geq 35$$

Where L=1-∇.

Forecasts obtained on the basis of (4) are superimposed on the actual observations in Figure 3. Their close agreement is remarkable. (Etuk et al., 2017).

proposed that an ARIMA model be fitted to the pre-intervention data. Suppose that this is given by

$$A(L)\nabla^d X_t = B(L)\varepsilon_t \qquad (1)$$

where $A(L) = 1 + \alpha_1 L + \alpha_2 L^2 + \ldots + \alpha_p L^p$ and $B(L) = 1 + \beta_1 L + \beta_2 L^2 + \ldots + \beta_q L^q$ and L is the backward shift operator defined by $L^k X_t = X_{t-k}$. The sequence $\{\varepsilon_t\}$ is a *white noise* process. It is clear that (1) may be written as

$$X_t = \frac{B(L)\varepsilon_t}{A(L)\nabla^d} \qquad (2)$$

On the basis of (1) or (2) forecasts are made for the post-intervention period. Suppose these are

F_t, $t \geq T$. Then $Z_t = X_t - F_t$ are modelled by

$$Z_t = c(1)*(1-c(2)\text{^}(t-T+1))/(1-c(2)) \qquad (3)$$

which is the intervention transfer function.

For instance consider the exchange rates of West African Franc (XOF) and the Nigerian Naira (NGN), I have studied a realization of the daily rates from 19th May 2016 to 13th November 2016. XOF is the currency of Benin, Burkina Faso, Chad, Cote d'Ívoire, Senegal, Togo and Mali. I chose the currency XOF because Nigeria is also in the West African region. The time plot of the XOF/NGN exchange rates is in Figure 2. The jump, from 0.3506 to 0.4862, in favour of the XOF was on day 35, that is on 22nd June 2016.

8. STATISTICAL APPLICATION IN LAW/SECURITY

The biblical story of Joseph's wrongful imprisonment in the house of Potiphar shows how, even in contemporary times, a person can be punished for no just cause, a situation avoided in law as much as possible. The use of a truth serum may limit this possibility. As an example, I answer this question from Walpole (1974: 34) but generalized:

A truth serum given to a suspect is known to be % reliable when the person is guilty and % reliable when the person is innocent. In other words, (100-)% of the guilty are judged innocent by the serum and (100-)% of the innocent are judged guilty. If the suspect was selected from a group of suspects of which only % have ever committed a crime, and the serum indicates that he is guilty, what is the probability that he is innocent?

Solution: By the application of Bayes theorem, the probability is given by

$$\frac{(100-\beta)(100-\delta)}{(100-\beta)(100-\delta)+\alpha\delta}$$

9. STATISTICS, THE MOST USED SUBJECT

- **Actuarial Science** is the use of mathematical and statistical methods for the study of risks in the insurance and finance industry.
- **Astrostatistics** is the application of statistical methods to study astronomical observations.

- **Biostatistics** is a branch of biology including medical statistics in which biological phenomena are studied by statistical methods.
- **Business analytics** is the application of statistical analysis to study business processes and decisions.
- **Chemometrics** is the application of mathematical and statistical methods to study chemical reactions.
- **Demography** is the statistical study of populations.
- **Econometrics** is the branch of economics involved in the mathematical and statistical study of economic theories and applications.
- **Environmental statistics** is the use of statistical methods in the study of human, animal and plant populations in an environment.
- **Epidemiology** is the application of statistics to study factors affecting human health and diseases.
- **Geostatistics** is the application of statistical methods in geographical branches of geophysics, oceanography, hydrology, etc.
- **Machine learning** enables computers to learn without programming.
- **Operations Research** is a multidisciplinary branch of mathematics which uses mathematical modeling and statistical methods to find optimum solutions to problems.

and by a *multiplicative-nil* SARIMA model it is meant the lhs of (3) such that 1s = s+1. Similarly a *nil-multiplicative,* a *nil-subset,* an *additive-nil* or a *subset-nil* SARIMA model may be defined.

13.2 Forecasting in the Face of an Intervention

In forecasting we say "all things being equal" to mean if there is no intervention. An *intervention* refers to an event which happens and changes the course of a time series in the process. The current economic recession in Nigeria has impacted on many time series. For example it has negatively affected the comparative value of the Naira. It has worsened inflation. An example of an intervention is the hiring of the German tactician Rohr as the head coach of the Super Eagles. It is clear that he has the magic of turning things around for the team because ever since he has been employed the team is yet to lose a match except for the June 10 loss to Bafana Bafana of South Africa. The ratings of the team by FIFA has also improved, tremendously. Interventions are often put in place to ameliorate certain negative trends. For example the Central Bank of Nigeria (CBN) has recently pumped in US Dollars into Foreign Exchange market and this has helped to reduce the relative value of the dollar.

Box and Tiao (1975) have developed an autoregressive integrated moving average (ARIMA) model-based approach to study the nature and degree of the impact of an intervention on a time series. Let t = T be the time of the intervention. It is being

19. I have proposed a novel SARIMA modeling algorithm (Etuk, 2016).

A stationary time series may be represented as a *general linear process* which may be defined as a moving average model of infinite dimension. It may be shown that both an AR(p) and an MA(q) are finite approximations of the process. The ARMA model resulted as a more parsimonioresentation of the process.

A merger of the two algorithms is hereby proposed as the novel algorithm. That is:

Fit the SARIMA(1,0,1)x$(1,0,1)_s$ model:

$$X_t + \alpha_1 X_{t-1} + \alpha_s X_{t-s} + \alpha_{s+1} X_{t-s-1} = \varepsilon_t + \beta_1 \varepsilon_{t-1} + \beta_s \varepsilon_{t-s} + \beta_{s+1} \varepsilon_{t-s-1} \quad (4)$$

The left hand side (lhs) of (4) is the AR component and the right hand side (rhs) the MA component. If both components are subset in the respective sense of (2) and (3), the resultant model may be called a *subset-subset* SARIMA model. If the lhs is additive and the rhs subset then the model may be called an *additive-subset* SARIMA model. Similarly, a *multiplicative-subset,* a *subset-additive,* an *additive-additive,* a *multiplicative-additive,* a *subset-multiplicative,* an *additive-multiplicative* and a *multiplicative-multiplicative* SARIMA model may be defined. It is also possible that the AR or MA component is not statistically significant. The word *nil* may be used to denote this possibility. For instance, by a *nil-additive* SARIMA model it is meant the model

$$X_t = \varepsilon_t + \beta_1 \varepsilon_{t-1} + \beta_s \varepsilon_{t-s}$$

- **Psychometrics** is an application of statistics to educational and personal traits studies.
- **Quality control** refers to application of statistics to industrial activities and processes.
- **Reliability engineering** is the application of probability models in the study of operational systems.
- **Statistical physics** is application of statistics to solve physical problems.

10. THE NIGERIAN STATISTICAL SYSTEM

Official statistics is the product of a statistical system. At the apex of the Nigerian Statistical System (NSS) is the National Bureau of Statistics (NBS) with the National Headquarters at Plot 762, Independence Avenue, Central Business Districts, Abuja. It has state secretariats. Its Rivers State Office is at the Second Floor of the Federal Secretariat Building. It is legally empowered to collect and publish data on all the sectors of the national economy. Other parastatals empowered to collect data are the Central Bank of Nigeria (CBN) and the National Population Commission. These also have their state offices. Data is collected and published as *Abstracts of Statistics, Digests of Statistics, Statistical Bulletins and journals.* For instance there is the *CBN Journal of Applied Statistics.*

Constitutions of Nigeria have put statistics on the concurrent list allowing the Federal, state and local governments to undertake collection, keeping and publication of statistics independently and simultaneously. The state offices of these parastatals are

statutorily given the responsibilities to collect their data. Ministries have Planning, Research and Statistics Departments (PRSDs) which collect data on the day-to-day events in their different areas of jurisdiction. Research and training institutes, Universities and polytechnics also collect data and use them to do researches. In particular, Nigerian Institute of Social and Economic Research (NISER), Centre for Economic and Allied Research (CEAR) and Federal Institute of Industrial Research, Oshodi (FIIO) are *inter alia* the research institutions. Training institutions include Federal School of Statistics (FSS) and Department of Statistics of Nigerian Universities and Polytechnics.

In existence is a Statistics Act of 2007 which empowers the NSS to raise awareness of the Nigerian populace of the need for accurate statistics for planning and governmental purposes; collect, analyze and communicate to the public accurate data; promote the use of international and best practices to produce, manage and disseminate statistics; encourage the use of statistics at personal, local, state, national and international levels for planning and monitoring purposes. The role of coordination of the NSS is given to two bodies, namely: The Board of Governors of the NBS and the National Consultative Committee on Statistics (NCCS). They are to examine the various programmes of the statistical agencies with a view to harmonizing them to produce a national statistical programme; providing advice on the welfare and the training of statisticians; ensure that uniform standards and methods are used by the various agencies so that high quality, timely and comparable

14. I have fitted a SARIMA(),1,1)x(1,1,1)12 model to Nigerian crude oil prices given by (Etuk, 2012)

$$\nabla\nabla_{12}X_t + 0.3523\nabla\nabla_{12}X_{t-12} = 0.1241\varepsilon_{t-1} + 0.5349\varepsilon_{t-12} + 0.4621\varepsilon_{t-13} + \varepsilon_t$$

15. We have modeled some Sudanese rainfall data in Gezira irrigation scheme in collaboration with a Sudanese hydrology specialist Tariq Mohamed (Etuk and Mohamed, 2014b).

$$\nabla_{12}X_t + .8858\varepsilon_{t-12} = \varepsilon_t$$

16. We have modeled South African Rand / Nigerian Naira Daily Exchange Rate as a SARIMA(1,1,1)x(1,1,1)7 model given by (Etuk and Amadi, 2014)

$$\nabla\nabla_7X_t - 0.8922\nabla\nabla X_{t-1} - 0.0234\nabla\nabla X_{t-7} + 0.0147\nabla\nabla X_{t-8} = \varepsilon_t - 0.9482\varepsilon_{t-1} - 0.9482\varepsilon_{t-7} + 0.9132\varepsilon_{t-8}$$

17. We have modeled Monthly Internally Generated Revenue of Rivers State as a SARIMA$(0,1,1)x(1,1,1)_{12}$ given by (Etuk et al., 2014b)

$$\nabla\nabla_{12}X_t + 0.2066\nabla\nabla_{12}X_{t-12} = \varepsilon_t + 0.1601\varepsilon_{t-1} + 0.9528\varepsilon_{t-12} + 0.1257\varepsilon_{t-13}$$

18. We have modeled domestic consumption of petroleum products in Nigeria as a SARIMA(0,0,1)x(1,1,1)12 model (Etuk and Amadi, 2013)

$$\nabla_{12}X_t + 0.5699\nabla_{12}X_{t-12} = 0.3566\varepsilon_{t-1} + 0.7244\varepsilon_{t-12} + 0.5236\varepsilon_{t-13} + \varepsilon_t$$

9. We have fitted a SARIMA(1,0,5)x(0,1,0)12 model to the Central African Franc/US dollar exchange rates given by

$$\nabla_{12}X_t - 0.7183\nabla_{12}X_{t-1} = \varepsilon_t + 0.4737\varepsilon_{t-1} + 0.2788\varepsilon_{t-2} + 0.2678\varepsilon_{t-3} + 0.1818\varepsilon_{t-4} + 0.2176\varepsilon_{t-5}$$

(Etuk and Nkombou, 2014)

10. We have fitted a SARIMA(0,0,0)x(0,1,1)12 model to the monthly flow of water in the Gadaref rainfall station of Sudan in collaboration with a Sudanese Civil Engineer and hydrologist, Tariq Mohamed given by (Etuk and Mohamed, 2014a)

$$\nabla_{12} X_t + .8858\varepsilon_{t-12} = \varepsilon_t$$

11. We have fitted in collaboration with the Ugandan accountant Bazinzi Natamba the following SARIMA(0,1,1)x(0,1,1)7 model to Daily Ugandan shilling – US dollar exchange rates (Etuk and Natamba, 2015)

$$\nabla\nabla_7 X_t + 0.2982\varepsilon_{t-1} + 0.9401\varepsilon_{t-7} = \varepsilon_t + 0.2648\varepsilon_{t-8}$$

12. We have fitted a SARIMA(0,0,1)x(1,1,1)12 model to Rivers State monthly allocation given by

$$\nabla_{12}X_t + 0.3110\nabla_{12}X_{t-12} = \varepsilon_t + 0.3998\varepsilon_{t-1} - 0.3343\varepsilon_{t-12} - 0.8888\varepsilon_{t-13}$$

(Etuk et al.,)

13. We have put forward an alternative definition to subset SARIMA modeling with a new algorithm using duality arguments (Etuk and Ojekudo, 2015).

data might be produced. Whether the Nigerian public is adequately sensitized and educated by provisions of this Act is doubtful. ` However, on the 21st April 2008 there was a Radio Nigeria announcement of an Annual Economic Survey organized by the National Bureau of Statistics, Central Bank of Nigeria (CBN) and Nigerian Communications Commission. The announcement came with a warning that anybody who failed to comply would be punished in line with the Statistics Act of 2007, the CBN Act of 2007 and the Communications Act of 2003.

Problems of data collection in Nigeria include the fact that the NSS is decentralized. There is lack of awareness of the populace of need for accurate data and this is exacerbated by illiteracy. Registration of vital events like births, deaths, marriages, accidents, etc. is not always done as they happen as the statistical act is not enforced.

11. NIGERIAN POPULATION CENSUS

Census is a statistical exercise. It is either *de jure* i.e. counting according to the people's place of usual residence, or *de facto* i.e. counting persons at their locations at the time of the census. The next head count in Nigeria is scheduled for 2018. The country has had a rather chequered Population Census history. There were headcounts in 1952-53, 1962, 1963 and 2006. By far the most accepted was the 1963 census for which the country's population was put at 53.5 million. Over-politicization has been the major bane of the exercise. There has been a steady improvement in the planning and execution of the exercise.

Legally empowered to take charge of population matters is the National Population Commission NPC established in 1988. It is commissioned to be conducting census and thereby collecting, collating and publishing Nigerian demographic data.

Table 2: Nigerian Population from Census, 2006

	South-East			
	Male	Female	Total	% of the Nation
Abia	1,434,193	1,399,806	2,833,999	2.02%
Anambra	2,174,641	2,007,391	4,182,032	2.99%
Ebonyi	1,040,984	1,132,517	2,173,501	1.55%
Enugu	1,624,202	1,633,096	3,257,298	2.33%
Imo	2,032,286	1,902,613	3,934,899	2.81%
SubTotal	8,306,306	8,075,423	16,381,729	11.70%

	South-South			
	Male	Female	Total	% of the Nation
Akwa-Ibom	2,044,510	1,875,698	3,920,208	2.80%
Bayelsa	902,648	800,710	1,703,358	1.22%
Cross-River	1,492,465	1,396,501	2,888,966	2.06%
Delta	2,074,306	2,024,085	4,098,391	2.93%
Edo	1,640,461	1,577,871	3,218,332	2.30%
Rivers	2,710,665	2,474,735	5,185,400	3.70%
SubTotal	10,865,055	10,149,600	21,014,655	15.01%

	South-West			
	Male	Female	Total	% of the Nation
Ekiti	1,212,609	1,171,603	2,384,212	1.70%
Ogun	1,847,243	1,810,855	3,658,098	2.61%
Ondo	1,761,263	1,679,761	3,441,024	2.46%
Osun	1,740,619	1,682,916	3,423,535	2.45%
Oyo	2,809,840	2,781,749	5,591,589	3.99%
Lagos	4,678,020	4,335,514	9,013,534	6.44%
SubTotal	14,049,594	13,462,398	27,511,992	19.65%

1. I have compared the performance of Partial Autocorrelation Function (PACF) and Inverse Autocorrelation Function (IACF) for autoregressive order determination (Etuk, 1988).
2. I have proposed a new ARMA modeling algorithm (Etuk, 1996b).
3. I have compared the performance of AIC and BIC under different conditions (Etuk , 1996a).
4. We have constructed a cost-efficient MV-optimal design (Etuk and Mbegbu, 2007).
5. We also have fitted a knapsack model to the budgetary allocation in Rivers State of Nigeria (Etuk et al., 2012)
6. We have proposed zero-lag white noise vector bilinear autoregressive time series models (Etuk and Iwok, 2012).
7. We have fitted a SARIMA(0,1,0)x(2,1,1)12 model to monthly Naira/Pound exchange rates given by

$$\nabla\nabla_{12}X_t + 1.1697\nabla\nabla_{12}X_{t-12} + 0.7014\nabla\nabla_{12}X_{t-24} = \varepsilon_t - 0.8611\varepsilon_{t-12}$$

(Etuk and Igbudu, 2013)

8. I have fitted a SARIMA(0,1,1)x(0,1,1)12 model to monthly Nigerian Stock Prices given by

$$\nabla\nabla_{12}X_t = 0.016553\varepsilon_{t-1} - 0.840362\varepsilon_{t-12} - 0.059566\varepsilon_{t-13} + \varepsilon_t$$

(Etuk, 2012)

TABLE 6: FORECASTS FOR 2016 AND 2017

Month	Forecast
January 2016	27,259.2
February 2016	28,408.1
March 2016	27,391.6
April 2016	28,280.4
May 2016	27,721.3
June 2016	27,647.9
July 2016	28,012.8
August 2016	27,144.2
September 2016	28,081.8
October 2016	27,093.5
November 2016	27,789.0
December 2016	27,402.6
January 2017	27,303.5
February 2017	27,751.8
March 2017	26,968.3
April 2017	27,833.3
May 2017	26,997.7
June 2017	27,570.8
July 2017	27,315.7
August 2017	27,163.5
September 2017	27,635.7
October 2017	26,914.7
November 2017	27,694.3
December 2017	26,990.1

	North-Central			
	Male	Female	Total	% of the Nation
Benue	2,164,058	2,055,186	4,219,244	3.01%
Kogi	1,691,737	1,566,750	3,258,487	2.33%
Kwara	1,220,581	1,150,508	2,371,089	1.69%
Nasarawa	945,556	917,719	1,863,275	1.33%
Niger	2,032,725	1,917,524	3,950,249	2.82%
Plateau	1,593,033	1,585,679	3,178,712	2.27%
SubTotal	9,647,690	9,193,366	18,841,056	13.46%

	North-East			
	Male	Female	Total	% of the Nation
Adamawa	1,606,123	1,561,978	3,168,101	2.26%
Bauchi	2,426,215	2,250,250	4,676,465	3.34%
Borno	2,161,157	1,990,036	4,151,193	2.97%
Gombe	1,230,722	1,123,157	2,353,879	1.68%
Taraba	1,199,849	1,100,887	2,300,736	1.64%
Yobe	1,206,003	1,115,588	2,321,591	1.66%
SubTotal	9,830,069	9,141,896	18,971,965	13.55%

	North-West			
	Male	Female	Total	% of the Nation
Jigawa	2,215,907	2,132,742	4,348,649	3.11%
Kaduna	3,112,028	2,954,534	6,066,562	4.33%
Kano	4,844,128	4,539,554	9,383,682	6.70%
Katsina	2,978,682	2,813,896	5,792,578	4.14%
Kebbi	1,617,498	1,621,130	3,238,628	2.31%
Sokoto	1,872,069	1,824,930	3,696,999	2.64%
Zamfara	1,630,344	1,629,502	3,259,846	2.33%
SubTotal	18,270,656	17,516,288	35,786,944	25.56%

	Abuja(FCT)			
	Male	Female	Total	% of the Nation
	740,489	664,712	1,405,201	1.00%

	Nigeria			
	Male	Female	Total	% of the Nation
Nigeria	71,709,859	68,293,683	140,003,542	100.00%

Source: www.nigeriamasterweb.com/Nigeria06CensusFigs.html
accessed 4th August 2017

Population Pyramid

A population pyramid is a graphical display of the population on the basis of age group with the youngest at the base and the older ones sequentially upwards. There are basically three types of pyramid. Below are typical examples.

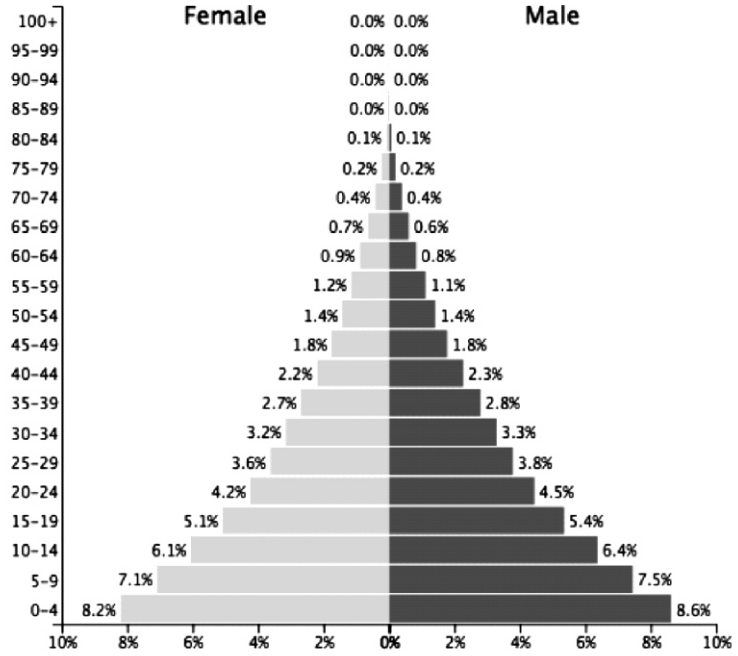


Figure 2: Nigerian Population Pyramid in 2017, population 191,835,936

Source: https: www.populationpyramid.net/world/2017/ accessed 4th August 2017

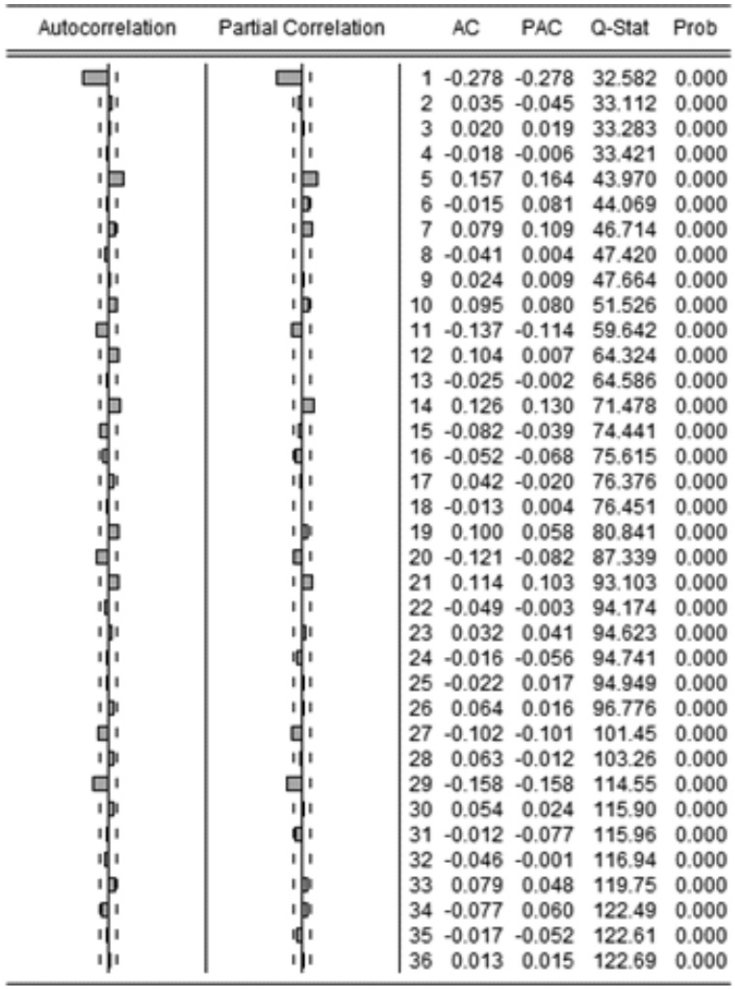
TABLE 5: ESTIMATION OF THE ARIMA (5,1,5) MODEL

Dependent Variable: DNEXR
Method: Least Squares
Date: 05/29/17 Time: 20:41
Sample (adjusted): 1981M07 2015M12
Included observations: 414 after adjustments
Convergence achieved after 19 iterations
MA Backcast: 1981M02 1981M06

Variable	Coefficient	Std. Error	t-Statistic	Prob.
AR(2)	0.970487	0.080253	12.09287	0.0000
AR(4)	-0.521450	0.130644	-3.991369	0.0001
AR(5)	0.328462	0.101600	3.232882	0.0013
MA(2)	-1.018495	0.094478	-10.78024	0.0000
MA(4)	0.570874	0.140848	4.053132	0.0001
MA(5)	-0.210200	0.104806	-2.005605	0.0456

R-squared	0.064920	Mean dependent var	54.99928
Adjusted R-squared	0.053461	S.D. dependent var	2070.685
S.E. of regression	2014.575	Akaike info criterion	18.06859
Sum squared resid	1.66E+09	Schwarz criterion	18.12694
Log likelihood	-3734.198	Hannan-Quinn criter.	18.09166
Durbin-Watson stat	2.547893		

Inverted AR Roots	.88 -.88-.44i	.44+.44i	.44-.44i	-.88+.44i
Inverted MA Roots	.67 -.86+.41i	.53-.25i	.53+.25i	-.86-.41i



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	-0.278	-0.278	32.582	0.000
		2	0.035	-0.045	33.112	0.000
		3	0.020	0.019	33.283	0.000
		4	-0.018	-0.006	33.421	0.000
		5	0.157	0.164	43.970	0.000
		6	-0.015	0.081	44.069	0.000
		7	0.079	0.109	46.714	0.000
		8	-0.041	0.004	47.420	0.000
		9	0.024	0.009	47.664	0.000
		10	0.095	0.080	51.526	0.000
		11	-0.137	-0.114	59.642	0.000
		12	0.104	0.007	64.324	0.000
		13	-0.025	-0.002	64.586	0.000
		14	0.126	0.130	71.478	0.000
		15	-0.082	-0.039	74.441	0.000
		16	-0.052	-0.068	75.615	0.000
		17	0.042	-0.020	76.376	0.000
		18	-0.013	0.004	76.451	0.000
		19	0.100	0.058	80.841	0.000
		20	-0.121	-0.082	87.339	0.000
		21	0.114	0.103	93.103	0.000
		22	-0.049	-0.003	94.174	0.000
		23	0.032	0.041	94.623	0.000
		24	-0.016	-0.056	94.741	0.000
		25	-0.022	0.017	94.949	0.000
		26	0.064	0.016	96.776	0.000
		27	-0.102	-0.101	101.45	0.000
		28	0.063	-0.012	103.26	0.000
		29	-0.158	-0.158	114.55	0.000
		30	0.054	0.024	115.90	0.000
		31	-0.012	-0.077	115.96	0.000
		32	-0.046	-0.001	116.94	0.000
		33	0.079	0.048	119.75	0.000
		34	-0.077	0.060	122.49	0.000
		35	-0.017	-0.052	122.61	0.000
		36	0.013	0.015	122.69	0.000

Figure 7: Correlogram Of The First Differences

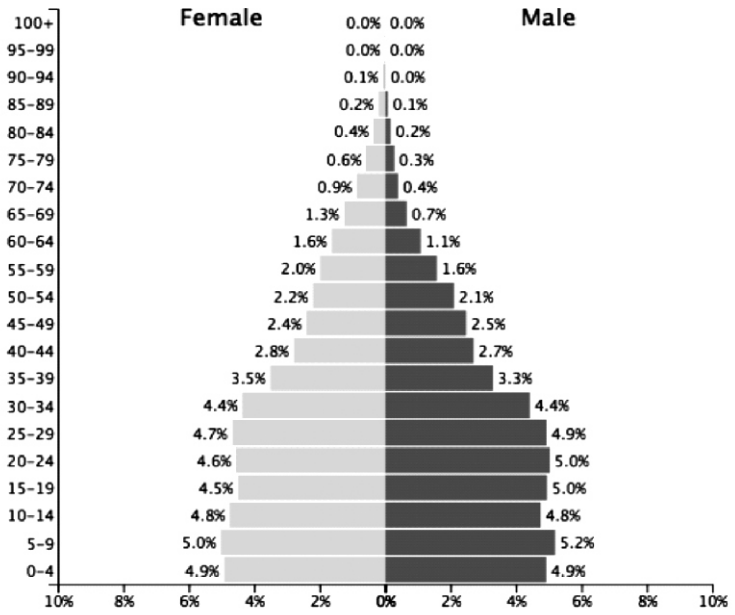


Figure 3: South African Population Pyramid in 2017, population 63,854,425

Source: https: www.populationpyramid.net/world/2017/ accessed August 2016

Clearly the Nigerian population pyramid is bottom-heavy whereas its South African and Netherland counterparts much less so. More than half of the Nigerian population is under 30 years of age. It is clear that more than half of Netherland population is above 30 years of age. That explains why Nigeria is by far less developed than the Netherland. The three examples of pyramids are of the expansive, stationary and constrictive types respectively. The **expansive** type, of which the Nigerian case is an example, has a broad base comprising the young cohorts and tapers upward. This is characteristic of the developing nations with very poor living

conditions and a high fertility rate. The **stationary** type of pyramid is exemplified by South Africa. The pyramid shows a non-growing population and has a fairly rectangular shape and tapers towards the top. It is characteristic of developed countries where birth rates are low and the quality of living is high. The Netherlands pyramid is of the **constrictive** type, which represents a predominantly elderly population and tapers towards the bottom. Countries in this category are developed with low birth rates and good living conditions with highly literate populations and good healthcare.

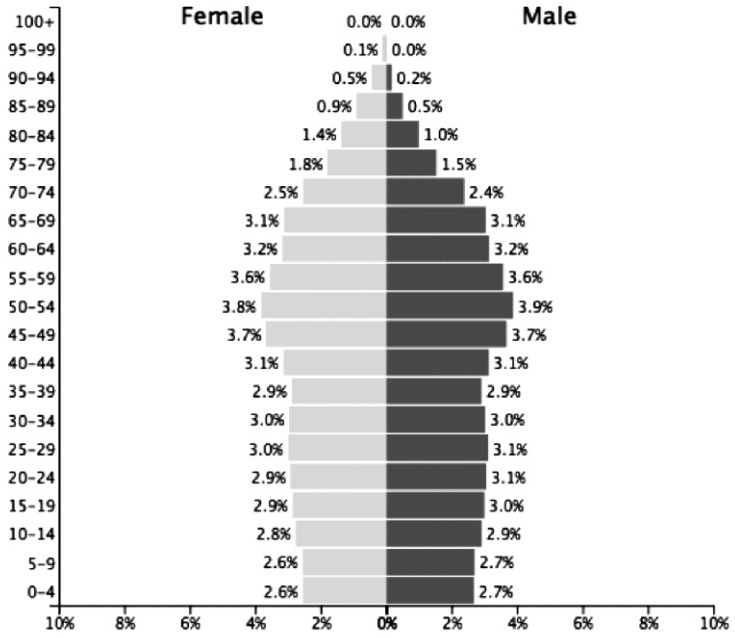


Figure 4: Netherlands Population Pyramid in 2017, population 17,032,845

Source: https: www.populationpyramid.net/world/2017/ accessed 4th August 2017

Table 4: Unit Root Test For The First Differences

Null Hypothesis: DNEXR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=17)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-27.12786	0.0000
Test critical values:	1% level	-3.445776	
	5% level	-2.868235	
	10% level	-2.570401	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DNEXR)
Method: Least Squares
Date: 05/29/17 Time: 21:44
Sample (adjusted): 1981M03 2015M12
Included observations: 418 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DNEXR(-1)	-1.278029	0.047111	-27.12786	0.0000
C	71.33386	97.01185	0.735311	0.4626

R-squared	0.638864	Mean dependent var	-2.305981
Adjusted R-squared	0.637996	S.D. dependent var	3295.233
S.E. of regression	1982.635	Akaike info criterion	18.02701
Sum squared resid	1.64E+09	Schwarz criterion	18.04632
Log likelihood	-3765.646	Hannan-Quinn criter.	18.03465
F-statistic	735.9208	Durbin-Watson stat	2.024115
Prob(F-statistic)	0.000000		

Any model so fitted to data is bound to be uncertain. Not only is it based on the analysis of a *realization* (sample) of the series, with the inference extended to the entire *ensemble* (population), but also it includes items of *white noise* which are shocks or error terms.

For an illustration, I hereby analyze Nigerian monthly reserve from 1984 to 2015.

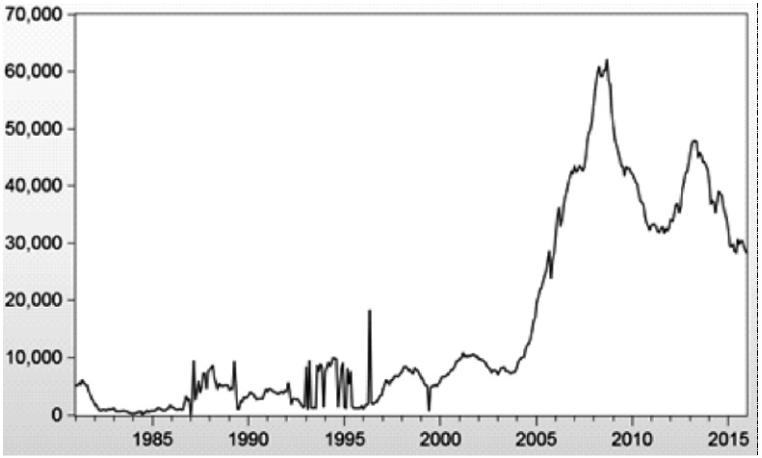


Figure 6: Nigerian External Reserves (us $ Millions)

12. STATISTICS, THE MOST ABUSED SUBJECT

By abuse of statistics I mean the misuse, misinterpretation and misapplication of statistics. Needless to say, it is non-statisticians that are mostly the culprits of this abuse. Nigerian data are often not timely nor consistent especially if from different sources.

i. Wrong sampling.

The sample should be as representative of the population as possible. The ideal thing is to use probability sampling methods like the simple random, systematic, stratified and cluster designs. Admittedly, some scenarios do not lend themselves to some of these approaches. It is acceptable to use non-probability methods like quota or convenience sampling. However, the more representative the sample is, the better.

ii. Tampering with data.

Falsification of data definitely results in an unacceptable inference. Where data from different sources do not tally, data from at least one source has been compromised. For example the 2016 national population is put at 140,431,790 (National Population Commission, 2017}. Another source puts it as 140,003,542 (Nigeriamasterweb, 2017). On 10 December 2016, the building of Reigners' Bible Church collapsed at Uyo. The number of deaths was reported as more than 200 by Vanguard, the next day. The Agency Report of January 9, 2017, put the number of deaths as

27. No meaningful results and inferences can come out of wrong or falsified data. A statistician is trained to acknowledge data integrity and sanctity. Research is the pursuit of the truth and no truth can come out false data. A lot of data are cooked up with various motives. Below in Table 3 are the 4-year crude-oil export data from the Nigerian National Petroleum Corporation (NNPC) and the CBN. The NNPC data are in barrels and the CBN data (parenthesized) are in millions of barrels per day (mbd). It may be argued that they are coded versions of one another. But clearly there is a lot of conflict or contradictions between the data from the sources; for example, for the months of July and August, 2015 with NNPC data, the July value of 64,864,137 is less than 66,137,563 of August and with the CBN record the July value of 1.73 is more than the 1.67 of August and both months have the same number of days. The same argument goes for January and March of 2013. Why the discrepancy?

Table 3: Four-year Nigerian crude oil exports

Year/ Month	2012	2013	2014	2015
January	69,067,879(1.78)	67,225,757 (1.78)	66,549,045 (1.84)	68,662,222 (1.75)
February	66,348,663(1.95)	53,000,330 (1.78)	68,620,615 (1.83)	64,901,642 (1.76)
March	66,794,717(1.89)	71,131,048 (1.75)	64,875,941 (1.76)	62,676,976 (1.62)
April	71,735,025(1.85)	63,023,818 (1.79)	69,876,801 (1.77)	63,988,262 (1.58)
May	65,602,709(1.95)	60,071,796 (1.61)	66,482,726 (1.88)	61,720,263 (1.60)
June	74,880,498(1.92)	56,892,775 (1.58)	65,376,913 (1.71)	59,569,676 (1.52)
July	70,214,352(1.97)	66,139,246 (1.75)	62,324,237 (1.61)	64,864,137 (1.73)
August	79,637,780(2.03)	68,446,299 (1.84)	70,137,932 (1.75)	66,137,563 (1.67)
September	69,325,453(2.00)	65,798,905 (1.84)	67,217,486 (1.65)	66,157,835 (1.77)
October	63,045,795(1.74)	63,284,658 (1.78)	64,222,744 (1.76)	70,313,959 (1.76)
November	60,033,979(1.58)	62,493,899 (1.64)	65,035,774 (1.73)	65,484,498 (1.73)
December	75,564,323(1.76)	64,536,670 (1.66)	65,933,895 (1.78)	65,952,619 (1.63)

Sources: NNPC ASB 2015 – 1st Edition and www.cbn.org

It is particularly important to be keeping records of past and present events in the life of an individual or a corporate body because these records might be the basis of forecasting into the future. A medical doctor often needs to know a patient's medical history in order to know how to handle the patient's case. A student should take stock of his/her academic records so as to know what next to expect or how much more to put in. The trader needs to know how much he has progressed in order to be able to project into the future. Record keeping will always be beneficial for everybody.

There exists the more modern stochastic approach to time series analysis whereby the series is modeled using stochastic models of the autoregressive integrated moving average (ARIMA) family or the GARCH family, to mention a few. Time series analysis invariably starts with the time plot, then the correlogram which is the graph of the autocorrelations and of course partial autocorrelations. The autocorrelation structure may suggest the fit of certain models to the data.

Modeling is on the basis of the *stationarity* of the data. Data are said to be stationary if their probabilistic properties do not change with time. It is only a stationary series which can be realistically forecasted. A non-stationary time series may be transformed into a stationary one by sufficiently differencing it according to Box and Jenkins (1976). When a model is to be fitted there is a condition of *invertibility* which must be met to ensure the uniqueness of the model for the given autocorrelation function (ACF). This condition is a computational requirement.

someone's expectations on the research results. At the end of it all, someone would have been misled or deceived.

viii. Displaying misleading graphs.

Newspapers all the time use charts to mislead the naïve and ignorant public. They do these in a variety of ways including changing the scale of the graph; the same graph on different scales cannot look the same way.

13. MY CONTRIBUTIONS TO KNOWLEDGE

For a very prolific writer like me it is not possible to discuss all my contributions to knowledge within one hour. I shall however list out the ones I deem the most important.

13.1 Time Series Analysis

As a statistician, I am a time series specialist. A time series is a set of data collected sequentially in time. Time series data have the characteristics of being correlated rather than being independent like other data are assumed to be. The future generally is based on the past. That also appeals to our intuition because "what a man sows that shall he reap". Time series analysis could be done by a traditional approach which involves the unraveling and separation of the series into the traditional components of secular trend, the seasonal component, the cyclical component and the irregular movement. Thereafter these components are reassembled additively or multiplicatively for the purpose of forecasting into the future.

iii. The parametric test and the non-parametric test dichotomy.

Parametric tests are used if parametric assumptions like normality are fulfilled. They are best used with interval and ratio data. On the other hand, non-parametric tests are best applied with nominal and ordinal data.

iv. Ignoring theoretical assumptions.

Statistical tests are based on some theoretical assumptions, violations of which may invalidate the results. For instance, the Student's t-test, the z-test and analysis of variance (ANOVA) are based on the assumption of independence of the samples and that the populations of interest follow a Gaussian or normal distribution. Violation of this assumption might make the results untenable. Therefore prior to the use of these tests fulfillment of the assumptions needs be ascertained by appropriate tests.

v. Inappropriate treatment of outliers.

An outlier is an item of data which is out of tune with the rest of the data. Many outliers are deliberate manipulations of data. For instance, in the Punch Newspaper of July 10, 2013, the news had it that "Plateau United Feeders beat Akurba Football Club by 79 – 0. Police Machine Football Club demolished Babayaro Football Club by 67 – 0." In the This Day Newspaper of 26 August 2013 it was reported that "140 graduates of the Covenant University, Ogun State, were

recently awarded first class degrees while 720 graduates received second class upper degrees. Similarly the Babcock University graduated 1,359 students, of which 52 bagged first class degrees while 1,059 graduates received second class upper division." These records may be true but are works of fixing and fabrications. Guinness Book of Records is a record of genuine outlying and exceptional events. Such a genuine event is that on May 7, 2017, the Nigerian musician Femi Kuti has broken world saxophone record set in 1997 by Kenny G. of the longest single note at 46 minutes 38 seconds. The last record stood at 45 minutes 37 seconds (Vanguard, May 8, 2017). Some measures like the mean and the variance are very sensitive to such extreme values. The traditional approach is to leave out the outlier and analyze the rest of the data. However there are situations where the extreme data item is genuine and leaving it out may not be advisable. Figure 5 shows an example of an outlier.

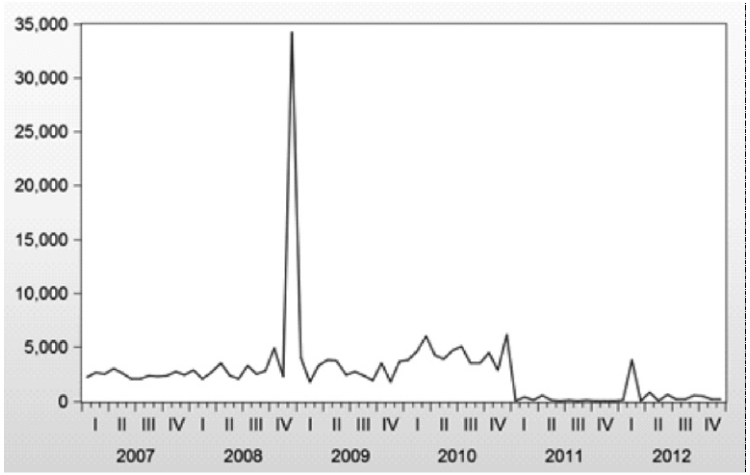


Figure 5: Outlying Rivers State Internally Generated Revenue In 2008 Q4

Source: Etuk et al, 2014a

vi. Wrong mathematical calculations.

A lot of calculations could be wrong. Recently, I have had the opportunity of correcting a wrongly calculated Pearson's moment coefficient of correlation r which was more than 1 in one of University senate sessions before Senate approval with the usual "Approved? Approved". By its functional structure r cannot fall outside of the real number range from -1 to 1.

vii. Wrong conclusions.

I have seen where the null hypothesis was wrongly rejected. I have seen a lot of misinterpretations of the p-value. Some of these errors are deliberate so as to force