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**THE BOOK OF ABSTRACT**

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**STATISTICAL ANALYSIS OF THE IMPACT OF COVID – 19 ON THE ECONOMY OF NIGERIA.**<sup>1</sup>Adikwu Joseph<sup>1</sup> Benue State Polytechnic, Ugbokolo, Benue state.*Corresponding Author: josadik@yahoo.com*

This research work is on the analysis of the impact of COVID-19 on the economy of Nigeria. The advent of coronavirus brought the world's financial system to its knees. Giving the trade data obtained, the analysis was done with a state-of-the-art gravity model of trade for Nigeria; within and without. Additional analysis was conducted using R at 95% and 99% confidence interval to determine the amount of impact. From the analysis, it was observed that the impact of COVID – 19 is of a greater negative impact within Nigeria and with other countries that were members of regional trade agreements before the pandemic. Secondly, the analysis indicated that the impact of COVID-19 on the indicators related to governmental actions is negative and significant. Furthermore, this negative effect is more when we consider its effect on exportation. Government has started making efforts to bolster this significant negative effect by increasing government spending and reduce tax for businesses.

*Keywords: Coronavirus, Covid-19, Economy, Trade data, Budget.*

**A NEW POISSON-EXPONENTIAL-GAMMA DISTRIBUTION FOR MODELLING COUNT DATA WITH APPLICATIONS**<sup>1</sup>Yahya Waheed Babatunde ; <sup>2</sup>M. A. Umar<sup>1</sup> University of Ilorin, Ilorin, Nigeria<sup>2</sup> Bayero University, Kano, Nigeria*Corresponding Author: wbyahya@unilorin.edu.ng*

In this paper, a new member of the Poisson family of distributions called the Poisson-Exponential-Gamma (PEG) distribution for modeling count data is proposed by compounding the Poisson with Exponential-Gamma distributions. The first four moments about the origin and mean of the new PEG distribution were obtained. The expressions for its coefficient of variation, skewness, kurtosis, and index of dispersion were equally derived. The parameters of the PEG distribution were estimated using the Maximum Likelihood Method. Its relative performance based on the Goodness-of-Fit (GoF) criteria were compared with those provided by five of the existing related distributions (Poisson, Negative-Binomial, Poisson-Exponential, Poisson-Lindley, and Poisson-Shanker distributions) in the literature on three different published real-life count data sets. The GoF assessment of all these distributions was performed based on the values of their loglikelihoods ( $-2\log\text{Lik}$ ), Akaike Information Criteria, Akaike Information Criteria Corrected, and Bayesian Information Criteria. The results showed that the new PEG distribution was relatively more efficient for modelling (over-dispersed) count data than any of the five existing distributions considered. The new PEG distribution is therefore recommended as a credible alternative for modelling count data whenever relative gain in the model's efficiency is desirable.

*Keywords: Poisson-Exponential-Gamma, Poisson-Exponential, Poisson-Lindley, Negative Binomial, Poisson Distribution, Goodness-of-fit.*

**NON-PHARMACEUTICAL INTERVENTION (NPI) PROJECTION OF COVID-19 OUTCOME INDICATORS USING MODELS WITH INVERSE HYPERBOLIC SINE RESTRICTIONS**

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Hyperbolic Exponential Growth Model (HEGM) was proposed to suppress the limitation of the Exponential Growth Model (EGM) developed through the Malthusian perspective for modeling biological processes. Studies have shown that EGM models growth without upper bounds. This study developed a modified version of EGM with bounds by conditioning the inverse hyperbolic sine function on the intrinsic rate of growth through an allometric parameter to control the divergence rate of the intrinsic rate of increase in order to stabilize the process. Non-Pharmaceutical Intervention projection using COVID-19 data was used to demonstrate the effectiveness of the developed Hyperbolic model.

*Keywords: Growth models, Hyperbolic Models, Non-Pharmaceutical Interventions (NPIs), Modeling, Malthusian*

**THE TITLE OF MY ABSTRACT IS**

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*Keywords: Keyword, Keyword, Keyword, Keyword, Keyword, Keyword, Keyword*

**INNOVATE TIMELY DATA FOR SDGS IN COVID-19 ERA.**

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Abstract Good quality data and statistics are important for informing development decisions. Timely data is important for the implementation and communication of the Sustainable Development Goals (SDGs). The United Nations Sustainable Development Goals (SDGs) or Agenda 2030 was set in 2015 by 193 countries. The SDGs are based on social, political, and environmental inclusion. Half of the data needed for “the decade of action” is either out-of-date or unavailable and we are not on track in achieving the global goals. The 2030 Agenda for Sustainable Development reflects a unique global consensus and commitment to address the world’s most acute and pressing challenges. But to achieve the Sustainable Development Goals (SDGs) and to leave no one behind, everyone in the world should be represented in up-to-date and timely data that can be used to measure progress and make decisions and improve people’s lives. However, too many of our data remain out-of-date, and too many people are missing from the numbers, especially during the COVID-19 pandemic where the demand for data and statistics is greater than ever but they are in short supply in many parts of the World. This paper aims at advocating the use of a new data ecosystem (big data) in communicating and measuring SDGs, provides robust methods and tools that can improve the timeliness, coverage, and quality of SDG data.

*Keywords: COVID-19, Big Data, SDGs and Timely Data*

**BIOTECHNOLOGY ROLE IN CLIMATE CHANGE ADAPTATION AND MITIGATION ON SOME CROPS PRODUCTIONS IN NIGERIA**

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The impacts of climate change on food production are increasing global threats, and the degree of the impacts on some crops productivity in Nigeria depends largely on the availability of technological expertise for their mitigation. Agriculture in Nigeria is highly vulnerable to the impacts of climate change with increasing drought, flooding, and incidence of pests and diseases as the major factors induced or exacerbated by climate change scenarios. The impacts of these abiotic and biotic factors result in low crop productivity, hunger, poverty, and diseases as prevalent in Nigeria. Biotechnology is a veritable tool that can be deployed for rapid responses to the impacts of climate change on agriculture. The focus of biotechnology in dealing with these issues includes reduction of greenhouse gas emissions and development of climate-resilient crops. Modern biotechnology has additional capacity to combine multiple traits in a single crop variety to produce varieties adapted to multiple environmental stresses. Modern biotechnology has also created unlimited opportunities for crop improvement through its capacity to source genes for desired traits from distantly related species. This paper examined the anthropogenic causes of climate change and the current status of biotechnology response strategies in Nigeria. It revealed increasing deforestation, fossil fuel combustion, agricultural activities, and poor waste management, exacerbated by population pressure and economic growth, as major anthropogenic factors driving climate change in the country, and highlights the need for Nigeria to strengthen her capacity to deal with climate change issues using biotechnology approaches.

*Keywords: Agriculture, Climate Change, Crops Adaptation, and Biotechnology*

**AN APPLICATION OF CATANOVA AND LOGISTIC REGRESSION ON THE MOST PREVALENT SEXUALLY TRANSMITTED INFECTION (A CASE STUDY OF THE UNIVERSITY OF NIGERIA TEACHING HOSPITAL)**

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This research focused on the application of CATANOVA and logistic regression analyses on the most prevalent Sexually Transmitted Infection (STI) reported in the University of Nigeria Teaching Hospital from 2010-2020. A population of 20,704 patients was recorded to have contracted eight(8) selected STIs. Prevalence analysis was computed to determine the most prevalent STI. Two-way CATANOVA cross-classification was computed to ascertain age group and gender that suffer more from the most prevalent STI, three-way CATANOVA was computed to ascertain the relationship among drug prescription, age, and gender of the patients and Logistic regression model was fitted to predict infertility. The prevalence analysis results showed Gonorrhoea infection as the most prevalent STI. A sample size of 364 was collected from the population of 6,850 patients recorded to have contracted Gonorrhoea infection from 2010-2020 using Andrew fishers' formula. Two-way CATANOVA cross-classification results showed that gender, age and interaction effects were statistically significant. Male (58.8%) suffers Gonorrhoea infection more than female (41.2%) and age of 30-39 years (34.3%) suffers it more than any other age interval. Three-way CATANOVA result showed that drugs for Gonorrhoea infection treatment depend on gender and age. Logistic regression model using dependent variable (fertile(0) and infertile(1)) and independent variables (Age, History, Blood Sugar, Bacteria Quantity, Body Mass Index and Blood Pressure) showed that odds of the Gonorrhoea patients are significant. This study is to inform the populace about STIs, the most prevalent STI, the gender and age interval that are more likely to be at risk of them. It also fitted a statistical model that assists medical practitioners to predict fertility status of STIs patients.

*Keywords: Chi-square Test, Contingency Table, Odds Ratio, Significance Level, Prediction*

**WIGHTED INVERTED GENERALIZED EXPONENTIAL (WIGE) DISTRIBUTION**

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This paper introduces the Weighted Inverted Generalized Exponential (WIGE) distribution as inducing inverted weight function into existing Inverted Generalized Exponential distribution. Various statistical properties of the proposed distribution were explicitly derived and the method of maximum likelihood estimation was used in estimating the model parameters. The model was applied to a real life data sets and its performance and flexibility was assessed with respect to existing distributions using the log-likelihood and Akaike Information Criteria as basis for judgment.

*Keywords: Exponential distribution, Generalization, Inversion, Statistical Properties, Weighted distributions*

**A COMPLEMENTARY APPROACH IN PREDICTING MAGNITUDE OF FLOOD ALONG FOMA RIVER USING CROSS-SECTIONAL VARIABLES**

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Flood hazards have been on the increase in recent years especially along the river bank. The hazards tends to impact on human lives and results in severe economic damages across the world. However, forecasting the magnitude of flood especially in Nigeria across the coastal areas have been hindered by several complications, including inaccurate data, poor assessment of drainage basin, pollution, and encroachment. This study made use of the Geographical Information System (GIS) tools to derive cross-sectional variables that were significant in complementing the prediction of the magnitude of flood along Foma-river areas. Global Position System (GPS) was used to obtain the coordinate points along the river areas, google earth imagery and topographical data of the study areas were obtained. The basin areas, streamlines, lengths of the river and its tributaries were also generated. The buffering of the river in 15 and 30 meters exposes the vulnerability status of structures along the river. Out of the 530 structures captured, 49 structures were highly vulnerable, while 105 structures were fairly vulnerable to flood hazards. The predictive accuracy of the ordered logit model approximated 81%. While a 10% error in classification was resulting from the harmonization of the precision value (0.8026) and the recall value (0.6386). The cross-sectional variables that were found to be significant at  $\alpha = 0.005\%$  are the river watersheds, the vulnerability status classification of structure across the river areas, the vulnerable structures identified, inadequate bridges and culverts along the river areas, inappropriate size of bridges and culverts, and extreme pollution along the river areas. This study is recommending the use of significant cross-sectional variables to complement the prediction of magnitude of flood along the river banks.

*Keywords: Buffering, Cross-sectional, Georeferenced, Magnitude, Spatial*

**ON AUTOREGRESSIVE CONDITIONAL POISSON AND INTEGER-VALUED ARMA MODELS: AN APPLICATION TO INSURANCE CLAIMS**

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Time series data can either be real or integer-valued, real-valued series is modeled using ARMA/ARIMA, SARIMA, ARFIMA and other dynamic models with white noise innovations. Modelling integer-valued series with these set of models is almost impossible or impractical due to problems of discreteness, overdispersion as well as autocorrelation. To remedy these aforementioned problems, integer-valued counterparts such as ACP, INARMA, INARFIMA and other integer-valued models assuming discrete marginal distributions such as Poisson and Negative Binomial had been proposed by researchers and adopted massively in modeling counts data. However, Actuaries pay little or no attention to these models as they often ignore these problems inherent in count data. The major objective of this study is to fit an appropriate model to insurance claims. Monthly auto-insurance claims of AXA Mansard Insurance Plc. were used. the study adopted both ACP and INARMA models since they address the problems of count data. Four ACP and three INARMA models were considered and the results showed that ACP (1,1) was the best model on the basis of AIC and BIC. Thus, we concluded that ACP (1,1) is the overall best model for the insurance claims under consideration.

*Keywords: Insurance claims, Bonus-Malus system, Binomial thinning, Count data, Overdispersion,*

**INVESTIGATION ON THE CHOICE AND USAGE OF CONTRACEPTIVES AMONG WOMEN OF REPRODUCTIVE AGE IN NIGERIA**

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This study aim to investigate the prevalence, use and choice of different contraceptive methods among Nigeria women of reproductive age (15 – 49 years, n=101,074). This study utilized the 2018 data sets from the National Demographic and Health Survey. The Chi-squares tests of Homogeneity of proportion was utilized to validate the equality of proportions for the different groups of contraception methods. Also, Multinomial Logistic Regression was employed to model the determinants of choice of contraceptive methods among some selected socio-demographical and maternal factors. Most Nigeria women within the reproductive age (n=84,756; 83.9%) do not use contraceptive either as a means of preventing pregnancy or sexually transmitted diseases. Among all the factors selected, Nigerian women from the South-West (SW), women with more desire for children and women within the age bracket 20 – 24, 25 – 29 and 45 – 49 are those factors that are significant (p-value > 0.05) to the usage and choice of contraception among Nigeria women. Some of the factors considered in this study indicated an increased risk (OR > 1.00) in the usage and choice of contraceptive methods while others indicated a reduced risk (OR < 1.00) in the usage and choice of contraceptive methods. Most women (45 – 49) who do not use contraceptive are those that are very close to or even at their menopause stage. The choice of contraceptive methods used by Nigerian women is influenced by most of the selected factors such as age, exposure to information, locality, religion, region, desire for children and partner's age. However, enlightenment programmes on the important and use of contraceptives are needed to be put on media to increase the usage of contraceptives among Nigerian women. Results from this study shows that all these selected variables are determinant to the type of contraceptive methods usage.

*Keywords: Contraceptives, NDHS, Chi-Squared test, Multinomial Logistic Regression*

**CONTROL CHARTS FOR MONITORING TUBERCULOSIS USING MARKOV DEPENDENT PROCESSES**

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Fadji, A.A., Adewara, J. A., Okorator. U., Bamidele, G. and Alakija, T. O. Department of Science Education<sup>1</sup>, School of Technical Education, Yabatech. Distance Learning Institute<sup>2</sup>, University of Lagos. Department of Statistics<sup>3,4,5</sup>, Yaba College of Technology, Yaba, Lagos. ABSTRACT The use of control charts in health management processes has not been fully explored as there are very scanty and few due to the fact that some researchers are skeptic that control charts can only be applied to health management processes since control charts have been known with ensuring quality of production processes. Therefore, we aimed at applying control charts through the use of augmented markov chain to health data on the application of DOTS to tuberculosis data. Two hundred and fifty (250) patients suffering from tuberculosis formed the respondents from which the data were obtained for this study. The results show that the initial frequencies of the two states of application are (Success = 45, Failure = 205). There were twenty five (25) transitions from success to success, twenty (20) transitions from success to failure, nineteen (19) transitions from failure to success and one hundred and eighty five (185) transitions from failure to failure. From the analysis, the probability of success falls below the lower control limit showing that the system (application) is out of control. DOTS has been used effectively in the treatment of tuberculosis patients yet some other advanced methods can equally be employed. We recommend that the application of DOTS and other advanced methods in the treatment of tuberculosis patients should be encouraged.

*Keywords: "Augmented", "Markov Chain", "DOTS", "Transition Probability Matrix", "Control Charts"*

**ANALYSIS OF VARIANCE OF THE REPORTED CASES OF COVID 19 IN THE SIX GEOPOLITICAL ZONES IN NIGERIA**

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Okorafor, U., Are, S. O. and Muhammed A. A. Department of Statistics<sup>1,3</sup>, Yaba College Of Technology, Yaba, Lagos, Nigeria. Mathematics<sup>2</sup> and Statistics Department, Federal Polytechnic, Ilaro, Ogun State, Nigeria. Correspondence Author: okoraforuneke@gmail.com This study investigated the "Analysis of Variance cases of COVID-19 confirmed cases in the six geopolitical zones in Nigeria. The occurrence of the coronavirus spread to over 196 countries across the globe by the index patient. While there are continuing efforts to limit the spread of infection in the 36 states in Nigeria. COVID 19 is a major public health problem both at the regional and in all geopolitical zones of the country. It has accounted for over 400,000 confirmed cases with over 2,000 deaths (CSEA AFRICA, 2020). The coronavirus is among the species of infections that cause various symptoms like fever, cough, lung infection etc. (WMHC, 2020). Several studies have estimated COVID 19 prevalence in the 36 state of Nigeria using the Analysis of Variance and Correlation techniques at the regional scale. We aimed at identifying COVID 19 cases and the Demographic and Health Survey (DHS) data for geopolitical zone among the six geo-political zones using Analysis of Variance and Correlation intervention programs. The study harnessed COVID 19 cases and analyzed the pattern of distribution. We used the Analysis of variance and chi- square as statistical tools. We also used Duncan test analysis to compare among the six geopolitical zones. The spatial distribution of COVID 19 cases showed statistically that South West geopolitical zone had a very COVID 19 cases when compared to the other five geopolitical zones in the 36 states of Nigeria. We recommend that as far as COVID 19 challenge is concerned, South West must be given more attention.

*Keywords: "COVID 19", "Analysis of Variance", "Correlation intervention", "Spatial distribution"*

**HYBRIDIZED ENCRYPTING ALGORITHM FOR TIME-BASED KEY WITH CIPHER-ZIG-ZAG BLOCK MATRIX FOR MITIGATING HACKING**

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Abstract The internet has become an integral part of our lives at all levels of our daily activities. Its usage is growing in an exponential rate during the last three decades and data (information) insecurity have become a major concern for anyone connected to the web. As such, every internet user is concern about data security to ensure that his or her information is only accessible by an intended (authorized) receiver. In order to achieve high level of secured information, it is observed that very many researches carried out using various methods of encryption were majored on single level of encryption. This study aims to increase the levels of data security using two-stage encrypting mechanism by applying Time-Based Encrypting Algorithm with a Hybridized Cipher-Zig-zag Block Matrix (with certain unique properties), which eventually enhances the encrypting mechanism and finally mitigating hacking.

*Keywords: Time-Based,, Zig-zag-Matrix, Ciphering, Cryptography, Encrypting*



**HYBRIDIZED ENCRYPTING ALGORITHM FOR TIME-BASED KEY WITH CIPHER-ZIG-ZAG BLOCK MATRIX FOR MITIGATING HACKING**

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Hybridized Encrypting Algorithm for Time-Based Key with Cipher-Zig-zag Block Matrix for Mitigating Hacking Department of Mathematics, Obafemi Awolowo University, Ile Ife 220005, Nigeria. A.J. Saka, K. A. Olurode., A. R. Adetona and T. G. Jaiyeola ajsaka@oauife.edu.ng, sakajamiu@gmail.com, olurodekaa@yahoo.com, adetonara@oauife.edu.ng, tjayeola@oauife.edu.ng

Abstract The internet has become an integral part of our lives at all levels of our daily activities. Its usage is growing in an exponential rate during the last three decades and data (information) insecurity have become a major concern for anyone connected to the web. As such, every internet user is concern about data security to ensure that his or her information is only accessible by an intended (authorized) receiver. In order to achieve high level of secured information, it is observed that very many researches carried out using various methods of encryption were majored on single level of encryption. This study aims to increase the levels of data security using two-stage encrypting mechanism by applying Time-Based Encrypting Algorithm with a Hybridized Cipher-Zig-zag Block Matrix (with certain unique properties), which eventually enhances the encrypting mechanism and finally mitigating hacking.

*Keywords: Keywords: Time-Based, Zig-zag-Matrix, Ciphering, Cryptography, Mapping and Encrypting.*

**CONVERGENCE AND ASYMPTOTIC BEHAVIOUR OF TRANSITION E-GARCH MODEL – AN APPLICATION TO NIGERIAN STOCK RETURNS**

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ABSTRACT The dynamic modelling of stock return with mean-equations that transits between unconditional and conditional variances reveals better forecast performance and predictive capability. An application of the TEGM demonstrates the random series estimate convergence and asymptotic structural behaviour significant for volatility modelling under innovation distributions. The daily dataset of All Shares Index (ASI) of the Nigeria Stock Exchange (NSE) were simulated at varying sample sizes: 20, 50, 100, 500, 1000 and 5000. The performance and predictive capability of the dynamic TEGM were shown using the Log-likelihood (LogL) estimates, Swartz Bayesian Information Criterion (SBIC), RMSE and MSE. The simulated data revealed that TEGM converge to global maximum, with "?, " LogL., SBIC, MSE and RMSE: for N = 20: (0.5367, 1.3970, 4.983, 0.0023 and 0.0484); N = 50: (0.7997, 1.9141, 36.1169, 0.0365 and 0.1910); N = 100: (0.7423, 1.4670, 34.1631, 0.0236 and 0.1536); N = 500: (0.7423, 1.5389, 366.0840, NaN and NaN); N = 1000: (0.2938, 0.2435, 0.1227 and 0.3503) and N = 5000: (0.2871, 0.2167, 0.1113 and 0.3337) respectively. It was deduced that TEGM realized more conditional variances than unconditional variances as sample size increased beyond 500. The model performance and predictive capability differs between data sample series under variants error distributions. The Transition Exponential Generalized Autoregressive Conditional Heteroscedasticity Model under SGED is the only GARCH family model that converge to global maximum. Its application is therefore recommended for making informed decisions on investments with higher returns and better predictive capability.

*Keywords: Convergence, asymptotic structure, variants innovation, performance and predictive capability.*

**MODELLING COVID-19 FLUCTUATION IN NIGERIA USING FRACTIONAL INTEGRATED GARCH MODEL**

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Modelling COVID-19 Fluctuation in Nigeria Using Fractional Integrated GARCH Model WIRI, Leneenadogo<sup>1</sup> Rivers State Ministry of Education, Port Harcourt Nigeria. Weesta12@gmail.com SIBEATE, Pius U.<sup>2</sup> Department of PRS (Statistics & EMIS Unit), Rivers State Ministry of Education, Port Harcourt, Nigeria. piussibeate@yahoo.com Abstract This study applied a fractionally integrated Generalized Autoregressive conditional heteroscedasticity (FIGARCH) process in modelling daily cases of COVID-19 in Nigeria from 28 February 2020 to 23 March 2022. The time plot of the series showed the constant fluctuation in the study variable. The daily COVID-19 data was tested for stationarity using Augmented Dickey-Fuller (ADF), the series was not stationary. The Geweke and Porter-Hudak (GPH) method was used to estimate the long memory parameter  $d$  of the FIGARCH model. The daily series was stationary at a fractional differencing of order ( $d=0.97$ ). The presence of long memory was also detected using the autocorrelation function. The fractionally integrated GARCH model was used to detect the period of high and low crisis. The crisis period was identified by volatility clustering and the leverage effect process. However, four models were estimated for FIGARCH models. The best model was selected based on the information criteria. Finally, the most adequate model for estimating the volatility of COVID-19 in Nigeria was the FIGARCH (1, 1) model.

*Keywords: Keywords: COVI19, Fluctuation, FIGARCH model, Long-memory process, the Autocorrelation function*

**A MODIFIED BREUSCH-PAGAN TEST FOR DETECTING HETEROSCEDASTICITY IN THE PRESENCE OF OUTLIERS**

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Heteroscedasticity is a problem that arises in regression analysis for a variety of causes. This problem impacts both the estimation and test procedures and it is therefore critical to be able to detect the problem and address it. The presence of outliers is a regular occurrence in data analysis and the detection of heteroscedasticity in the presence of outliers poses lots of difficulty for most of the existing methods. In this paper, a modified Breusch-Pagan test for heteroscedasticity in the presence of outliers was proposed. The modified test is obtained by substituting non-robust components in the Breusch-Pagan test with robust procedures which makes the modified Breusch-Pagan test to be unaffected by outliers. Monte Carlo simulations and real data sets were used to investigate the performance of the newly proposed test. The probability value ( $p$ -value) and power of all methods considered in this study were computed and the results indicate that the modified robust version of Breusch-Pagan test outperformed the previous tests significantly. The proposed modified Breusch-Pagan test is therefore recommended for testing for heteroscedasticity in linear regression diagnosis, especially when the data sets evidently contain outliers.

*Keywords: Heteroscedasticity, Outliers, Cook's Distance, S-estimation, Modified Breusch-Pagan Test, Monte Carlo Simulations*

**DISCRETE-TIME MARKOV CHAIN APPLICATION TO POPULATION GROWTH CONTROL IN LAGOS METROPOLIS**

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The study considered the birth gap with four states, length of breastfeeding with four states and type of contraceptives used with five states, by mothers with at least three conceptions in Lagos Metropolis, Nigeria. Data was obtained from the population using a self-designed and administered questionnaire. Results showed that the steady state probability of birth gap was highest at state 4 which is > 24 months implying that 3 out of five women on the long – run will space their births at more than 2 years which ultimately will lead to lower child birth, improved mother's welfare and healthier children. Also, the distribution of mothers and their switching after each period of childbirth shows that contraceptives are indeed effective in controlling conception. Lastly, the transition probabilities of the states are significantly greater than zero and the state are dependent on each other ( $p < 0.05$ ). The study therefore concluded that increased birth gaps, elongated length of breastfeeding and the use of contraceptives by mothers in Lagos Metropolis when combined will ultimately lead to slowing childbearing and population growth rate thereby serving as strong instruments in population growth control.

*Keywords: Birth gap, Length of breastfeeding, Markov chain, Population control, Transition probability*

**MODELING THE CASE FATALITY RATE OF NOVEL CORONAVIRUS DISEASE (COVID-19) AS HIDDEN MARKOV CHAINS**

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The Hidden Markov model has over the years been an appropriate method for modeling diseases such as HIV AIDS, heart failure and so on. With the ongoing pandemic affecting Nigeria by being responsible for 2,745 death cases out of 207,616 confirmed cases as of October 10, 2021, the need to study an important parameter of Covid-19, the case fatality rate by building a model and estimating the case fatality rate of Covid-19 in Nigeria using Lagos State as case study via hidden Markov approach arose. This study built the transition and emission probabilities of cases of Covid-19 and developed a model for understanding the trend of the virus. The relevant data were gathered from the website of Nigeria Centre for Disease Control (NCDC). The Forward Algorithm, Baum-Welch and Viterbi Algorithm were used to implement the objectives of this study and proffer answers to the research questions. The result shows that the estimate case fatality rate of Covid-19 in Lagos State between the periods under study was 4.35%. The likelihood of transitioning from a state of being infected to that of recovery is 25% and the probability of transitioning from a state of being infected to death 50% and the probability of still being infected is 25%. There are hidden states that influence the observable factors or variables of Covid-19.

*Keywords: Markov model, Hidden Markov Model, Covid-19, Case Fatality Rate.*

**MODELING SURVIVAL DATA WITH COVARIATES USING MARSHALL-OLKIN-GUMBEL-WEIBULL DISTRIBUTION**<sup>1</sup>Elebe Emmanuel Nwezza ; <sup>2</sup>Uchenna Ugwunnaya Uwadi ; <sup>3</sup>Oluchukwu C. Asogwa ; <sup>4</sup>Fidelis Ifeanyi Ugwuowo<sup>1</sup> Department of Mathematics and Statistics, Alex Ekwueme Federal University Ndufu, Alike Ikwo<sup>2</sup> Department of Mathematics and Statistics, Alex Ekwueme Federal University, Ndufu-Alike, Ebonyi State<sup>3</sup> Department of Mathematics and Statistics, Alex Ekwueme Federal University, Ndufu-Alike, Ebonyi State<sup>4</sup> Department of Statistics, University of Nigeria, Nsukka*Corresponding Author: emma\_nwezza@yahoo.com*

Distributions having bathtub shape failure rate function are known to have wide applicability in survival data analysis. In this paper, the applicability of Marshall-Olkin-Gumbel-Weibull distribution, which has bathtub shape failure rate function amongst other shapes, is extended in modeling survival data with covariates. The estimation of the parameters of the model is done using the maximum likelihood approach under non-informative censoring mechanism. Real-life dataset was used to illustrate the usefulness of the distribution.

*Keywords: Marshall-Olkin-Gumbel-Weibull, Survival data, Censored data, Covariates, Maximum likelihood*

**STOCHASTIC MODELING OF WASTAGE CONTROL IN A UNIVERSITY MANPOWER SYSTEM: A RECYCLE BIN APPROACH**<sup>1</sup>Ossai Everestus<sup>1</sup> Department of Statistics, University of Nigeria, Nsukka*Corresponding Author: everestus.ossai@unn.edu.ng*

In this work, a university manpower system with potential re-employment for a special class of workers who leave through the second type of wastage is modeled in a Markov framework. A recycle bin scenario is mimicked to set apart an additional class of members of the system in a state of limbo, from where they make transitions either back to the active class or to the outside environment. This depicts the true situation in the system where members who complete their tenure in the active class are retained or re-engaged under various agreements. The entire manpower system is presented in a departmentalized structure with  $k$  subgroups, the limbo class being the  $k$ th subgroup. By constructing the block matrix of intra-departmental and interdepartmental transition probabilities, the implication of choosing a new member, from either the outside environment or the limbo class, on the control of the system structure is investigated under different stochastic conditions.

*Keywords: Statistical manpower planning, Markov model, control, transition probability*

**ANALYSING NON-LINEAR RELATIONSHIPS USING SPLINE REGRESSION MODEL**<sup>1</sup>AJAO, Isaac Oluwaseyi ; <sup>2</sup>Adaraniwon, Adaraniwon Olalekan ; <sup>3</sup>Ilugbusi, Ayokunle Oluwatosin<sup>1</sup> Department of Mathematics and Statistics, Federal Polytechnic, Ado-Ekiti<sup>2</sup> Dept of Mathematics and Statistics, Federal Polytechnic, Ado-Ekiti<sup>3</sup> Dept of Mathematics and Statistics, Federal Polytechnic, Ado-Ekiti*Corresponding Author: isaacoluwaseyiajao@gmail.com*

There have been a lot of errors committed in analyzing datasets such as economic, medical, weather, and so on which do not have linear structure that have been wrongly analysed by using linear models, this has led to misspecification of models in many cases and of course wrong results and predictions. This paper therefore seeks to address this issue by recommending spline models using a non-linear simulated dataset. Results show that spline models is better than the conventional linear regression model (LRM), Generalized additive model (GAM), Polynomial models, and log-transformed model with minimum values from AIC = 82.6670, BIC = 139.8760, RMSE = 0.2502, MSE = 0.0626, and MAE = 0.1815 and maximum from R2 = 0.8129. These suggest that the spline regression model out-performs the other models when handling non-linear data and therefore recommended.

*Keywords: Spline, GAM, non-linear, predictions, models*

**COVID-19 AND SUSTAINABLE DEVELOPMENT GOALS (SDGS): IMPACT AND PROSPECTS**

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Prior to COVID-19, one of Nigeria's missions was better performance in the Sustainable Development Goals (SDGs). In 2020, Voluntary National Review (VNR) on SDGs, necessitated a focus on the critical issues of some SDGs like poverty; health and wellbeing; education; gender equality; economy; peace and security; and partnerships. VNR had made several efforts in enabling a policy environment for the implementation of the SDGs in the country. Unfortunately, instead of working towards achieving the set targets of the SDGs agenda by 2030, we are faced with the aggravated problems caused during the pandemic, which seem to have halted the progress on almost all the SDGs and hence require effective measures and strong participation to attain. The objective of this paper is to broaden the understanding of the perceived impact of the COVID-19 outbreak and to offer a critical reflection that would enhance the level of public awareness on potential alternative paradigms of realistic solutions.

*Keywords: COVID-19 Pandemic, Gender, Political, Economy, Social Change, Voluntary National Review*

**COVID 19: IMPLICATIONS FOR SUSTAINABLE DEVELOPMENT GOALS (SDGS)**

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The abnormal circumstances produced by the COVID-19 pandemic led to various consequences for society that caused changes in main sectors and highlighted the sustainability issues embraced in the Sustainable Development Goals (SDGs). Some of the activities that took place during the COVID 19 pandemic like the Lock-down period really affected the educational sector, health sector, and employment to mention but a few. On the other hand, it enhanced online education, forced home-office work, decreased working hours, reduced mobility, and so on. Stronger dependencies exist between education, health and wellbeing, the economy, and climate change. Also from the SDGs perspective, COVID 19 has enhanced gender equality and reduced inequality within and among countries. Nevertheless, the pandemic is an eye-opener to harnessing our potential and special opportunities for change in which sustainable Development Goals (SDG) issues must be addressed. This paper puts forward analysis and interpretation of the impact of the COVID-19 pandemic on the SDGs and also the insights generated which contribute to furthering our understanding of post-COVID-19 recovery.

*Keywords: Sustainability, Goals, Pandemic, Collaborations, Post-COVID 19*

**STOCHASTIC MODEL OF TUMOR IMMUNE INTERACTION WITHIN TUMOR MICROENVIRONMENT**

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The stochastic model of non-immunogenic tumor-microenvironmental factors on tumor growth in the presence of immune surveillance is investigated. The Novikov theorem, Fox approach and the Ansatz of Hanggi are used to obtain the approximate Fokker Planck equation for the transition probability of which the steady state distribution for the tumor growth system is derived. We find that the correlation time strength and the immune strength have opposite effect on both the steady state distribution and the stationary mean of the tumor population, with increase in correlation time strength promoting growth and increase in the immune response parameter reducing growth.

*Keywords: Stochastic Differential Equation, Fokker Planck equation, Gaussian Colored noise, Tumor-immune interaction*

**INVERSE GOMPERTZ DISTRIBUTION: PROPERTIES AND APPLICATIONS TO COMPLETE, TYPE-II RIGHT CENSORED AND UPPER RECORD DATA**

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This article studies the properties and application of two-parameter inverse Gompertz distribution and applications to upper record data. The main advantage of the new model is that it has "an upside-down bathtub-shaped curve hazard rate function depending upon the shape parameters. Several of its statistical and mathematical properties including quantiles, median, mode, moments, moment, entropy function, skewness, and kurtosis are derived. Moreover, the reliability and hazard rate functions. The maximum likelihood approach is used to estimate the new model parameters. Finally, the applicability of the proposed distribution is demonstrated with different engineering applications to complete, type-II right-censored, and upper record data. It is found that this model is more flexible when it is compared to well-known models in the statistical literature.

*Keywords: Inverse Gompertz, Type II right censored, Entropy function, Upper record data*

**DEVELOPING A MACHINE LEARNING MODEL FOR PREDICTING ASTHMA EXACERBATIONS**

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We share the machine learning details of a project to develop a model for predicting impending (within 15 days) asthma exacerbations. This was part of an effort to better utilize healthcare resources, prevent hospitalization and improve patient outcomes. Our work used the data of almost 30,000 asthma patients from electronic medical records and national registers. We show the rationale for our candidate predictors, candidate models, feature engineering, and the choice of metric and cross-validation scheme for model comparison, selection and evaluation. We show the most important identified predictors (comorbidity burden and previous exacerbations) and hold-out test performance (area under precision-recall curve = 0.007 (95% CI: ± 0.0002)). We discuss the reasons for these results and why they do not support the use of the developed model for the original purposes of the project, but also alternative uses of the gained insights in drug development.

*Keywords: prediction model, machine learning, asthma, exacerbation*

**IMPACT OF PREDICTED CONTROL GROUP OUTCOME AS A COVARIATE**<sup>1</sup>Emmanuel T. Adewuyi<sup>1</sup> Ladoke Akintola University of Technology, Ogbomoso*Corresponding Author: olex.taiwo@gmail.com*

The power of randomized controlled clinical trials to demonstrate the efficacy of a drug compared with a control group depends not just on how efficacious a drug is, but also on the variation in patients' outcomes. Adjusting for predictive covariates during trial analysis can reduce this variation. For this reason, the primary statistical analysis of a clinical trial is often based on regression models that besides terms for treatment and some further terms (e.g. stratification factors used in the randomization scheme of the trial) also includes a baseline (pre-treatment) assessment of the primary outcome. We suggest to include a "super-covariate" — i.e. a patient-specific prediction of the control group outcome — as a further covariate (or as an offset). For this, we train a prediction model or ensembles of such models on the individual patient (or aggregate) data of other studies in similar patients, but not the new trial under analysis. This has the potential to use historical data to make clinical trials smaller, faster and less resource intensive without the concern of type I error inflation with Bayesian approaches. Such prediction models would ideally generalize well across different patient populations in order to achieve a similar reduction in unexplained variability whether the trial(s) to develop the model are identical to the new trial or not. We illustrate the efficiency gains from the use of a "super-covariate" in an example in neovascular age-related macular degeneration.

*Keywords: super-covariate, predictive covariates, historical data, Bayesian approaches*

**TEMPORAL DYNAMICS OF COVID-19 POSITIVE CASES IN KATSINA STATE**<sup>1</sup>Rabe Anasu ; <sup>2</sup>Hamza Idris<sup>1</sup> Department of Mathematics and Statistics, Umaru Musa 'Yaradua University<sup>2</sup> Umaru Musa Yaradua University, Katsina.*Corresponding Author: anasu.rabe@umyu.edu.ng*

We investigate the spread of covid-19 infection in Katsina state between June and November, 2021. Study data consist of diagnostic results of polymerase chain reaction (PCR) test on nine hundred and eighty nine (989) nasal samples from suspected cases, collected at the federal medical centre Katsina, recording a total 137 positive cases over the study period. Our investigation revealed that covid-19 infection reaches its peak in October, when 27 females and 39 males tested positive, with 22 cases in the age range of 20 to 29 years.

*Keywords: Age, Covid-19, Diagnostic test, Infection,*

**A RESAMPLING ALGORITHM FOR MULTIVARIATE CONTROL CHART**<sup>1</sup>Okutachi Michael<sup>1</sup> Department of Mathematics and Statistics, Federal Polytechnic, Idah, Kogi State*Corresponding Author: austineokutachi@gmail.com*

In this article, we develop a multivariate control chart that can effectively identify outliers in multivariate data while keeping masking and swamping effect under control. We employed the agglomerative hierarchical clustering of a single linkage type to improve the Sullivan and Woodall's second method known as SW2 method. We evaluated the performance of the proposed method and compare it with the minimum volume ellipsoid control chart, minimum covariance determinant control chart, and the principal component analysis control chart using historical multivariate dataset from literature. Masking and swamping rates were the two criteria used for evaluation purpose. Additional Monte Carlo simulation experiment further verified that the Cluster-Based Multivariate Control Chart (CMCC) greatly improved the SW2 method and performed better in outlier Identification and swamping prevention.

*Keywords: Outlier identification, Masking and swamping effect, Multivariate control chart, Hierarchical clustering*

**PREVALENCE AND RISK FACTORS ASSOCIATED WITH HIGH BLOOD PRESSURE**<sup>1</sup>Ayodeji A.A ; <sup>2</sup>Etisioro. C.O ; <sup>3</sup>Ikegwu E.M ; <sup>4</sup>Olufolabo O.O ; <sup>5</sup>Okuwuchi C.G<sup>1</sup> YABA COLLEGE OF TECHNOLOGY, YABA, LAGOS.<sup>2</sup> YABA COLLEGE OF TECHNOLOGY, YABA, LAGOS.<sup>3</sup> YABA COLLEGE OF TECHNOLOGY, YABA, LAGOS.<sup>4</sup> YABA COLLEGE OF TECHNOLOGY, YABA, LAGOS.<sup>5</sup> YABA COLLEGE OF TECHNOLOGY, YABA, LAGOS.*Corresponding Author: kunle.ayodeji@yabatech.edu.ng*

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Abstract High blood pressure is one of the main public health risks problems in developed countries as well as developing countries. The behavior of the high blood pressure (HBP), in the initial phases of life has shown a strict relationship with hypertension in adulthood. Moreover, it has raised the interest of researchers in investigating the prevalence of high BP in childhood and adult, as well as its associated risk factors. This paper examined the knowledge, prevalence and risk factors of high blood pressure among undergraduate students in Yaba College of Technology. Cross sectional research design was adopted for the study and multi stage sampling techniques was used to select 391 participants while a standard questionnaire was administered to the selected respondents. Chi-square and binary logistic were used to analyse the data collected and it was found that 94.9% of the participants (male; 95.5% and female 91.8%) had good knowledge of high blood pressure, the overall prevalence was 43% (male 41.8% and female 49.2%) and the factors associated with HBP were smoking, alcohol, diets and knowledge.

*Keywords: High Blood Pressure, Risk Factor, Obesity, Heart Attack, Unhealthy Diet*



**ROBUST HOTELLINGS T2 TEST FOR DIFFERENCE IN MEAN**<sup>1</sup>Edibo Lami<sup>1</sup> Department of Mathematics and Statistics, Federal Polytechnic, Idah, Kogi State*Corresponding Author: edibolami@gmail.com*

This study proposes a multivariate test of hypothesis for two independent groups by robustifying the classical Hotellings T2 test statistic using the resampling algorithm proposed by Alih and Ong (2017). The algorithm estimates the robust location and scatter matrix by effectively identifying outliers in multivariate data while keeping masking and swamping effect under control. We evaluated the performance of the proposed method and compare it with other robust methods such as the minimum volume ellipsoid method and minimum covariance determinant method. Masking and swamping rates were the two criteria used for evaluation purpose. The Monte Carlo simulation experiment verified that the Cluster-based Hotellings T2 test, (CHTT) greatly minimized family-wise masking and swamping rates when compared with other robust methods. Areal-life illustration is presented.

*Keywords: Outliers, Masking and swamping, Cluster Algorithm, Independent Groups, Robustifying*

**LOGISTIC REGRESSION MODEL FOR FEMALE GENITAL MUTILATION: A FACTOR SCREENING APPROACH**<sup>1</sup>Edibo Lami ; <sup>2</sup>Okutachi Augustine Michael<sup>1</sup> Department of Mathematics and Statistics, Federal Polytechnic, Idah, Kogi State<sup>2</sup> Department of Mathematics and Statistics, Federal Polytechnic, Idah, Kogi State*Corresponding Author: edibolami@gmail.com*

Female genital mutilation (FGM) has three major types (Clitoridectomy, Excision, and Infibulation) arising from the degree to which the external genitalia of the female is affected. Its origin is shrouded in mystery but historical evidences point to Egypt as the source country before its spread through countries in sub-Saharan Africa, Asia, the Middle East, as well as some migrants in Europe, United States and Australia. This study examines the factors that cause the FGM practice in order to determine the causality variables in a logistic regression scenario. Based on the multistage stratified random survey conducted by the Nigeria Institute of Medical Research, Yaba, Lagos State, the tau statistic,  $\tau$  was used to screen 12 factors presumed to causes FGM in order to select few of the predictors before multiple regression equation is obtained. The need for this may be that the sample size may not be able to sustain having a regression with all the predictors or to avoid multicollinearity. A total of 3152 respondents comprising 1863 adult males and 1289 adult females were selected from the household survey based on the multi-stage sampling procedure. The tau-statistic,  $\tau$  showed that residence, employment status, educational level, aware of FGM problem, support campaign against FGM, wealth of the family, and location are the most highly associated variable to FGM. It was further observed that a large population of the respondents who are not in supports of the campaign against FGM is 2,309 but of this number, 2,159 does not support FGM and several of them (2,090) are educated. Since there is a considerable relationship between Education and employment status ( $r=0.43$ ), it could be said that the improvement in Education status could considerably improve enlightenment on the danger of FGM thereby discouraging the belief and the support for female circumcision in the African society.

*Keywords: African Society, Causality Variables, Female Genital Mutilation, Logistic Regression, Tau statistic*

**NEW GENERALIZED GAMMA-WEIBULL AND EXPONENTIATED- UNIFORM DISTRIBUTIONS WITH APPLICATIONS TO TIME-TO-EVENT DATA**

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This study introduced a new class of distributions called Generalized Gamma Weibull (GGW) and Gamma Exponentiated Generalized Uniform (GEGU) distributions in the realm of parametric survival analysis. The new distributions are modifications of gamma Weibull and Exponentiated generalized uniform distribution. A thorough and comprehensive investigation of these classes of distributions becomes necessary when the shape of a lifetime is highly skewed. Mathematical properties of these classes of distributions including hazard functions, moments, quantile functions, and order statistics were presented. The estimation of parameters of these new distributions via maximum likelihood technique, Fisher Information (FI), and asymptotic confidence intervals of both censored and uncensored situations were considered. Two real-life survival data and two real life-time data, which are made up of four different data sets were considered to illustrate the usefulness and applicability of these proposed classes of distributions. The study uses the Akaike Information Criterion (AIC), Corrected Akaike Information Criterion (CAIC), and the Bayesian Information Criterion (BIC) as measures of indices for comparing the newly modified family of distributions with the existing distributions such as Generalized Weibull and Generalized gamma (G-Weibull and G-Gamma) distribution. The results of the comparison revealed that the newly introduced class of distributions (GGW: AIC=338.6313, BIC=346.2794, and CAIC=339.5202) outperformed the existing methods (G-Weibull: AIC= 376.1946, BIC= 381.9307 and CAIC= 376.5424) based on the three criteria.

*Keywords: Generalized Gamma Weibull Distribution Gamma Exponentiated Generalized Uniform, Generalized Gamma, Exponentiated Weibull Distribution, Gamma Weibull Distribution, Gamma Distribution.*

**BAYESIAN PENALIZED CREDIBLE REGION IN HIGH DIMENSIONAL SURVIVAL DATA**

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The technique of Bayesian variable selection via penalized credible regions was developed to perform model fitting and variable selection in survival analysis via cox's proportional hazard model. The idea is to search for the sparsest solution within the joint posterior credible regions. More recently, improvements in the use of global-local shrinkage priors have been made for high-dimensional Bayesian variable selection. However, not many studies have been done to incorporate global-local shrinkage priors called Dirichlet-Laplace (DL) prior. This study is motivated to incorporate and adapt global-local shrinkage priors (DL prior) to cox's proportional hazard model and the tuning of hyperparameters in prior distributions for cox's PH model. The modified method was compared with the existing method using AIC, BIC, and DIC. The result of the simulation and real-life data revealed that the modified model outperform the existing method. Additionally, the proposed modified model selected a minimum number of genes than the existing method.

*Keywords: Variable selection, Cox's PH, Global-local shrinkage prior, DIC, Hyperparameters, Dirichlet Laplace.*

**PRINCIPAL COMPONENT ANALYSIS ON CONTRACEPTIVES MEASURES AMONG FEMALE STUDENTS OF OSCOTECH,  
ESA-OKE, OSUN STATE, NIGERIA**

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Abstract This research paper was conducted using sample survey on the use of contraceptive measures among female students of Faculty of Pure and Applied Sciences of Osun State College of Technology, Esa Oke., the data was extracted from dispatched questionnaires using Haphazard Sampling Method. The percentage of each variables under the factors is being reduced by 0.5 as operator to classify each of the variables. The first factor is loaded on X<sub>7</sub> and X<sub>8</sub>, the second factor is loaded on X<sub>12</sub>, there is no variable loaded on third factor, while the fourth factor is loaded on X<sub>3</sub>, X<sub>6</sub> and X<sub>11</sub>. The Communality and Unique variances were obtained as  $\sum_{i=1}^m a_{ij}^2$  and  $V(e_i) = 1 - \sum_{i=1}^m a_{ij}^2$  respectively. Lastly, F2 (Virginal Ring) has 32.175% Contribution which has the highest percentage contribution among all the methods regarded as the most appropriate method for preventing unwanted pregnancies.

*Keywords: Keywords: Contraceptive Drugs, Factors, Communality, Unique Variance, Percentage Contribution*

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*Keywords: Keywords: Contraceptive Drugs, Factors, Communality, Unique Variance, Percentage Contribution*

**DYNAMIC NON-LINEAR MODELLING OF PUBLIC VIOLENT DEATHS IN NIGERIA AS A STOCHASTIC PROCESS**<sup>1</sup>Umolo David ; <sup>2</sup>Shittu Olanrewaju I.<sup>1</sup> University of Ibadan<sup>2</sup> University of Ibadan*Corresponding Author: umolodavid@gmail.com*

Recently, research on violent death has been rare with less attention drawn to its dynamic nature. This study extensively explores the dynamic nature of violent death as a stochastic process using Nigeria Watch dataset on monthly violent death cases by causes in Nigeria from June 2006 to March 2021 (n=178). The methodology adopted for the study is Hidden Markov Model with Switching Autoregression (HMMSA) capturing the probability characteristics of the transition amongst the underlying regimes defined as (state 1: regular violence state; state 2: irregular violence state). Exploratory data analysis (EDA) including time plot, trend analysis, test of stationarity, test of normality, test of equality of distribution and boxplot were fully explored. It was discovered that violent deaths by majority of causes possessed statistically significant positive trend corresponding to non-normally and unevenly distributed on monthly basis. Political issue was found to be the major cause of violent deaths in Nigeria followed by crime, cattle grazing, fire explosion and land issue. The observational hidden states and their transition probabilities from one state to the other accordingly under the Gaussian/Poisson mixture and the grand transition probabilities of violent deaths for the identified causes were also estimated. These include Political issues [P<sub>11</sub>=0.6010, P<sub>22</sub>=0.8674, P<sub>12</sub>=0.3990 and P<sub>21</sub>=0.1326]; Road accident [P<sub>11</sub>=0.7328, P<sub>22</sub>=0.4275, P<sub>12</sub>=0.2672 and P<sub>21</sub>=0.5724]; among others. The regime switching equations were estimated to be statistically significant. The conditional and regime-based residuals, filtered and smoothed probability were also estimated with death count regime classification plots, the predictive plots for the predictive plots for best regime's model identification and parameter interval estimation. This study therefore recommends that further research which would allow for the building of sentry system for violence detection using Artificial Intelligence (AI) or Machine Learning (ML).

*Keywords: Markov Model, autoregression, violent death, politics, firearm.*

**QUANTILE PLOTS FOR OPTIMAL PREDICTION VARIANCE PROPERTIES OF SOME CENTRAL COMPOSITE DESIGNS IN THE HYPERCUBE**<sup>1</sup>CHARITY ONWUAMAEZE<sup>1</sup> DEPARTMENT OF STATISTICS, UNIVERSITY OF NIGERIA, NSUKKA*Corresponding Author: uchenna.onwuamaeze@unn.edu.ng*

Giovannitti-Jensen and Myers (1989) used variance dispersion graphs (VDG's) to assess the overall prediction capability of a response surface design inside a region of interest, R. The VDG's consist of plots of the maximum and minimum prediction variance values on concentric spheres inside R against their radii. These plots provide useful information about the amount of dispersion in the prediction variance throughout the region R. They do not, however, account for values of the prediction variance on a sphere other than its maximum and minimum. Quite often, information concerning the prediction variance distribution on a sphere will provide a more comprehensive and accurate assessment of the quality of prediction than it can be obtained from the VDG's. In this article, we describe such distribution by using a plot of its quantiles. A method for deriving these quantiles is given. examples are presented to illustrate the utility of the proposed approach.

*Keywords: "optimality, prediction variance, response surface, variance dispersion graph"*

**STATISTICAL ANALYSIS ON THE EFFECT OF ROMANTIC RELATIONSHIP ON ACADEMIC PERFORMANCE OF STUDENTS  
IN YABA COLLEGE OF TECHNOLOGY**

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1AMUSA, S.O; 2IDOWU, E.O 3ETISIORO, C.O; 4AJIBOYE, Y.O; 5FADIJI, A.A 1,2,3,4,5 DEPARTMENT OF STATISTICS, YABA COLLEGE OF TECHNOLOGY Corresponding Author's Address: saidi.amusa@yabatech.edu.ng ABSTRACT Academic performance is the degree to which a student accomplished their short or long term educational goals. The factors that contribute to academic success of students in their educational setting has been a topical issue as several works have been done by consideration of different variables with varied outcomes. The purpose of this study is to investigate the effect of romantic relationship on the academic performance of students. The hypothesis that romantic relationship between students in higher institutions of learning have effect on their academic performance was evaluated on final year students of Yaba College of Technology. The variables considered are relationship status of students, the number of times student attend lectures per week and Grade Point Average (GPA) which represents academic performance. The Data collection instrument (questionnaire) was administered to a total of 370 respondents selected by means of simple random sampling from eight stratum (schools) and analysis carried out with statistical tools such as frequency table, charts, cross-tabulation and Chi-Square test with the aid of SPSS Package. Findings showed that 76.0% of the respondents were in a relationship and that their status have no significant influence on the amount of time spent on studying ( $p > 0.05$ ) and no significance influence on the number of times student attend lectures per week ( $p > 0.05$ ). There was however significant association between students' relationship status and their attitude towards carrying-out their assignments/practical works ( $p < 0.05$ ). The study however found that there was no significant association between relationship status and academic performance ( $p > 0.05$ ). In conclusion, in order to have a successful academic life while maintaining a healthy romantic relationship, students should have good time management

*Keywords: Romantic Relationship, Academic Performance, Tertiary Institution, Grade Point Average, Chi-Square Test.*

**BAYESIAN MIXED LOGISTIC REGRESSION WITH CAUCHY PRIOR DISTRIBUTION**

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This research work was carried out to examine Bayesian mixed logistic regression with Cauchy prior distribution. Seven different priors such as Uniform, Jeffrey's, Gamma, Exponential, Cauchy and Normal distribution were used to model Bayesian Mixed Logistic Regression. Data obtained from Nigeria Centre for Disease Control database (Covid-19) and simulated data were used. The main finding is that the Jeffrey's prior outperforms the other alternative priors. The estimated log-marginal likelihood of the model for Jeffrey's prior for Covid-19 is -178.35169; while the model with normal priors is -194.26228, Uniform (-202.58957), Gamma (-187.44238), Exponential (-190.1489), Beta (-222.55253) and Cauchy priors (-212.37071) respectively. While for the model fit to the Covid-19 data using Uniform prior for number of cases confirmed, the 95% credible interval is (0.005, 0.006) is that, the data are consistent with an underlying infection rate of between 0.5% and 0.6% while for Jeffreys prior, the 95% interval is 0.006 and 0.007 respectively. The Jeffreys priors fit the data better for Covid-19 and simulated data. This indicated that the model with Jeffreys priors fits the data better. Finally, Bayesian mixed logistic regression reports an estimation table that includes the posterior mean, posterior standard deviation, MCMC standard error (MCSE), posterior median, and the 95% credible interval. Furthermore, Jeffrey's prior is more efficient than the other alternatives and it seems to be preferable to normal priors, Uniform, Gamma, Exponential and Cauchy priors.

*Keywords: Distributions, Bayesian, logistic regression, models, probabilities*

**CORONAVIRUS PANDEMIC IN NIGERIA: AN EXPLORATORY DATA ANALYSIS OF CLUSTERING PATTERN OF INFECTIONS, RECOVERIES AND DEATHS**

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COVID-19 has been recognized around the world as a serious pandemic whose occurrences have posed greater threats to human and economic sustainability. As of October 31, 2021, it had infected 211,961 people in Nigeria and caused 2,894 deaths since its outbreak in Wuhan, China. This has damaged the Nigerian economy and the global economy as a whole, thus ongoing modelling and forecasting becomes a priority. This study, on the other hand, examines the pattern of infection, recovery, and deaths at the state level using data derived from Nigerian Center for Disease Control (NCDC) reports over a period of 613 days and explored using K-means and agglomerated hierarchical cluster analysis. The Ward method for distance estimation and the average silhouette methodology for the optimal number of clusters were used as cluster quality indices. The clustering analysis performed on the states in Nigeria revealed homogenous groups of states that can be classified based on their population density and that two clusters may be optimal for grouping the states based on their similarities in the number of confirmed cases, recoveries, and deaths, with an accuracy of 88.3%, 89.4%, and 80% respectively. Based on the findings of the investigation, it was revealed that Lagos State has the highest value for the total number of confirmed cases, recovery cases, and death cases compared to all of the other states.

*Keywords: COVID-19, Data Exploration, Hierarchical Clustering, Pandemic*

**REGRESSION ANALYSIS OF BLOOD PRESSURE DATA ON THE JACKKNIFE KIBRIA-LUKMAN ESTIMATOR**

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In estimation of the parameters of a linear regression model, the Ordinary Least squared (OLS) method suffers a breakdown when the independent variables are linearly dependent – a condition called multicollinearity. The Kibria-Lukman estimator (KLE) was suggested as an alternative to the OLSE and some other estimators (Ridge, Jackknifed Ridge, Liu, Jackknifed Liu estimators). In this paper, the principle of Jackknifed is employed on a known best estimator of the parameter of a linear regression with multicollinearity to further reduce the bias thereby producing a more efficient estimator. The developed estimator which is a Jackknife version of the Kibria-Lukman estimator is called Jackknifed K-L estimator (JKLE). We derived the statistical properties of the new estimator and compared it theoretically with the some estimator and also the KLE in literature. Theoretically, the result revealed that JKLE possesses the lowest mean squared error (MSE) when compared with the ridge, jackknifed ridge, liu, jackknifed liu and then the KLE estimators. Finally, JKLE reduced the bias and the MSE of KLE in real application of Blood pressure data in Nigeria.

*Keywords: Jackknifed Kibria-Lukman, linear regression model, Ridge, OLS, multicollinearity*

**A MULTIPLE CHANGE-POINT MODELLING FOR GAUSSIAN BASED MODELS: GIBBS SAMPLING APPROACH**

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A Bayesian framework is developed to detect multiple change-points in vector mean with constant and covariance for normally distributed datasets. An informative prior distribution for the means and covariance were adopted to obtain a conjugate posterior distribution. Based on the sampling from an estimated informative prior for the parameters mean and covariance and the posterior distribution of hypotheses, the methodology is applied to Standard and Poors 500 index and Geological mineral datasets. Although, the model under study seems quite simple, but no analytic solutions for parameter inference are available, and recourse to approximations is needed. It was shown that the Gibbs sampler is particularly suitable for change-point analysis, and this Markovian updating scheme is used in addition with Greedy-Algorithm to detect multiple points of change in the considered two datasets .

*Keywords: Change point analysis, Bayesian method, multiple change-points, Greedy-Algorithm, Gibbs Sampling, Posterior Distribution.*

**FITTING BIRTH AND DEATH QUEUING MODELS USING MAXIMUM LIKELIHOOD ESTIMATION WITH APPLICATION TO COVID-19 PANDEMIC IN SUB-SAHARAN AFRICA**

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The Covid-19 pandemic has revealed facts about deficiencies in health resource planning of some countries having relatively high case count and death toll. The virus has undergone an observed increase of cases that led to a global pandemic. Many authors have developed different models for predicting or observing the current trend of Covid-19 pandemic. In this study, fitting birth and death models using maximum likelihood estimation (MLE) method with application to Covid-19 in sub-Sahara Africa is proposed. Real life data on Covid-19 from World Health Organization (WHO) and other online resources was used to determine probability distributions of infected, recovery and death of Covid-19 patient in some selected Sub- Sahara countries: Nigeria, Kenya, South Africa and Central African Republic (CAR) from inception of the disease to 10th November, 2021. The MLE method was used to determine the probability of getting infected with Covid-19; the probability of having more than n Covid-19 active cases in a susceptible population; the average survival time of the virus in a system; and the average number of Covid-19 active cases per day. The result of the analysis showed that the probability of recovery is above 0.9 for the selected countries except for Central African Republic which is 0.5924 and South Africa has the highest mortality rate of 3.06%. Kenya has the highest probability of having more than 10 Covid-19 cases. Kenya also has the highest survival time for the virus and has the highest number of Covid-19 active cases per day. The results fit well to the case data of the sample corona center. Current preventive and responsive resource planning depends on accurately designed models and methods needed for the prediction of future threats, and mitigation costs.

*Keywords: Birth and death process, Covid-19 pandemic, Maximum likelihood estimation, Simple queuing system, sub-Sahara African*

**ON MODELLING OF RETROSPECTIVE APPRAISAL OF PHARMACEUTICAL INTERVENTIONS AND NON-PHARMACEUTICAL PROTOCOLS IN REDUCING TRANSMISSION OF COVID-19 IN NIGERIA**

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Implementations of both pharmaceutical interventions and non-pharmaceutical protocols were geared towards the protections of public from contacting COVID-19. Impact of these had been inconsistent and unclear in Nigeria. This study aimed at measuring the effectiveness of pharmaceutical interventions (first, second and booster dose of COVID-19 vaccine) and major non-pharmaceutical protocols (hand washing, use of sanitizers, social distancing, and self isolation). Methods and analysis include item response modelling of responses to constructs made by simple random sampling of 2500 respondents from 4 states and federal capital territory using stata 17SE and the results suggested that lower social status individuals embraced hand washing, use of sanitizers and social distancing in that order from non-pharmaceutical ends while pharmaceutical interventions were mainly for high social status citizenry.

*Keywords: Effectiveness, interventions, protocols, pharmaceuticals, responses*

**USE OF LOGISTIC REGRESSION MODEL TOWARD AVAILABILITY AND UTILIZATION OF LABORATORY FACILITIES ON ENACTMENTS OF UNDERGRADUATE SCIENCE STUDENTS**

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**Abstract** This study was designed to examine effects of availability and use of laboratories on students' performance in Nigeria universities. The study was conducted in five universities which consist private, state and public universities. The study examined the availability of laboratories, examine the use of laboratories, and assess the availability of lecturer, and 'perceptions how laboratories availability influence students' performance in science courses. Survey research design was used and the study employed quantitative approaches where observation, checklist, school records and Likert scales were used for data collection. The sample of the study include 5 heads of department, and 10 lecturers. The data were analyzed using frequency count, percentages and regression models. Findings revealed that schools did not have modern laboratories; instead they had science rooms which lacked laboratory space. It was noted that apparatus and chemicals were either insufficient or absent in all sampled department; instead some department improvised those equipment by using locally available materials in their environment. Experiments were done in large groups with little students. There was an acute shortage of lecturer. It was recommended that, policy makers need to ensure that students enrolment should match with the availability of laboratory facilities, more laboratory need to be built in most universities and more lecturer and technician need to be trained. **Keywords:** laboratory, logistic regression, equipment, availability, university.

*Keywords: laboratory, logistic regression, equipment, availability, university.*



**STUDY ON EFFECT OF SOME SELECTED SOCIO-ECONOMIC INDICATORS ON ECONOMIC GROWTH IN NIGERIA**

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This paper investigates the impact of some selected socio-economic variables on Gross Domestic Product (GDP) in Nigeria based on dataset from 1991 to 2019. Using OLS technique to multiple linear model, the results from the analysis suggests that the independent variables year, percapita, GNI, inflation rate, manufacturing output, export and import have significant impact on GDP in Nigeria because their coefficients are statistically significant to the fitted model based on multiple linear model with GNI contributing about 35% variation in GDP values follow by per capita with about 29%, then manufacturing output about 23%, export 8%, year 5%, import 4% and inflation rate 2% respectively. Thus, government may also need to re-adjust its policy and priorities to socio-economic variables that have high variation on GDP. Doing this would not only complements and improve the competitiveness of various sector in economic growth and productivity of the nation but may also corrects for the observed insignificant and negative impact of the variable on Nigeria's economic growth.

*Keywords: GDP, Multiple regression, Model, Socio-economic variable*

**A STUDY ON EFFECT OF SORGHUM SPENT GRAIN ON GROWTH PERFORMANCE OF BROILER CHICKEN**

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Maize is a major source of dietary energy in poultry nutrition and there is stiff competition for maize among humans and the livestock industry. This competition for conventional feedstuff has contributed immensely to the high cost of ingredients and fluctuation in feed supply in our local markets thus, creating a problem for the poultry industry in the area of providing good quality feed at affordable prices thereby making poultry production and expansion more expensive. This paper examined the effect of sorghum spent grain (SSG) as an alternative supplemented with feed enzyme on the growth performance of broiler chicken. Data were collected on growth performance traits which are factor A and percentage SSG inclusion levels as factor B and were analyzed using ANOVA based on factorial design. The results reveal that there is a significant difference in the growth of broilers based on growth performance traits and percentage inclusion level of SSG as well as the interaction effect between growth performance traits and percentage inclusion level of SSG at a 5% level of significance.

*Keywords: Broiler chicken, Growth performance, SSG, Factorial design*

**STATISTICAL ANALYSIS OF EFFECTS OF ENVIRONMENTAL FACTORS ON CHILD'S SURVIVORSHIP AT BIRTH**

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Abstrac We studied statistically those factors which determine the survivorship of a child at birth. The data used in this work was obtained from the Delivery Register of Our Lady of Loudes Mission Hospital Ihiala, Anambra state of Nigeria. The data covered all births recorded from January 2012 to December 2013. Factors which determine the survival of a child at birth are numerous but for this work, variables of a greater influence were considered which include: Mother's age, Parity, Mother's Diagnosis/health condition before delivery, Method of Delivery, Sex of the baby, Birthweight and the State of the child at birth i.e. if the baby is alive or dead at birth. It was found by chi-square test that the mother's diagnosis/health condition before the delivery of a child is a key significant factor that determines the child's survivorship at birth with p-value 0.000 and Ho rejected at 0.05 level of significant while the mother's age, parity and the child's birth weight yielded a p-value of 0.222, 0.154 and 0.747, Ho accepted at 0.05 level of significant. Z-test yielded a p-value of 0.000, Ho rejected of no significant difference between the proportion of liveb myirth by SVD and C/S at 0.05 significant levels which implies that the method delivery of a child determines the child's survivorship at birth and the proportion of dead birth by SVD = 0.6 is higher than that of C/S = 0.4 which is an evidence that C/S can serve as a remedial measure to cub problems associated with delivery. When the state of the child by the means of the Doctor, Midwife and Nurse attended delivery were subjected to comparison by ANOVA technique, the F-Test yielded a p-value of 0.701 which implies that child's survival at birth is independent upon who attended to the child's delivery.

*Keywords: Livebirth, Stillbirth, Low Birthweight, Chi-Square, P-Value.*

**STATISTICAL ANALYSIS OF EFFECTS OF ENVIRONMENTAL FACTORS ON CHILD'S SURVIVORSHIP AT BIRTH**

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Abstrac We studied statistically those factors which determine the survivorship of a child at birth. The data used in this work was obtained from the Delivery Register of Our Lady of Loudes Mission Hospital Ihiala, Anambra state of Nigeria. The data covered all births recorded from January 2012 to December 2013. Factors which determine the survival of a child at birth are numerous but for this work, variables of a greater influence were considered which include: Mother's age, Parity, Mother's Diagnosis/health condition before delivery, Method of Delivery, Sex of the baby, Birthweight and the State of the child at birth i.e. if the baby is alive or dead at birth. It was found by chi-square test that the mother's diagnosis/health condition before the delivery of a child is a key significant factor that determines the child's survivorship at birth with p-value 0.000 and Ho rejected at 0.05 level of significant while the mother's age, parity and the child's birth weight yielded a p-value of 0.222, 0.154 and 0.747, Ho accepted at 0.05 level of significant. Z-test yielded a p-value of 0.000, Ho rejected of no significant difference between the proportion of liveb myirth by SVD and C/S at 0.05 significant levels which implies that the method delivery of a child determines the child's survivorship at birth and the proportion of dead birth by SVD = 0.6 is higher than that of C/S = 0.4 which is an evidence that C/S can serve as a remedial measure to cub problems associated with delivery. When the state of the child by the means of the Doctor, Midwife and Nurse attended delivery were subjected to comparison by ANOVA technique, the F-Test yielded a p-value of 0.701 which implies that child's survival at birth is independent upon who attended to the child's delivery.

*Keywords: Livebirth, Stillbirth, Low Birthweight, Chi-Square, P-Value.*

**INDEX NUMBER ANALYSIS ON SOME SELECTED FOODSTUFFS (CASE STUDY OF OGUN STATE NIGERIA)**

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It is usually known that the most essential aid of good standard of living for human growth health and development is food. However in most developed countries of the world like USA, UK, Canada, Saudi Arabia, etc. the staple food price are given higher priority and, because they want food to be affordable by everyone. It is quite unfortunate in country like Nigeria where people die of hunger. No wonder Nigeria tagged "poverty capital of the world". As a result of this, the aim of this research work is to examine the variation in prices and quantities of most common staple food items and also seek the lively cause of high price in the items. The data for the research work, was collected from the National Bureau of Statistics (NBS) records, and it consist the price and quantities of common staple food like maize, local rice, garri, beans, palm oil, onion, tomato, yam, tubers etc. between the years 2007 to 2021, using 2017 as the base year. The statistical package used for the analysis was SPSS and Index-Number, price-quantity analysis was adopted. It was revealed from the result and findings that the commodity prices increased at the average rate of 25% while people's consumption increased at the rate of 33%. Perhaps, it could be due to population, increment over the years or low level of agriculture productivity. We therefore recommend that government should encourage teenage youth towards agricultural practices and give out loan facilities to the real practicing farmers. Also there should be an establishment of price control task-force.

*Keywords: Price Relative Index, Simple Aggregate Price Index, Laspeyre Price Index, Pasche's Price Index, Fisher Ideal Price Index, Marshal Edge-Worth Price Index*

**GENERATING CLASSES OF GENERALIZED DISTRIBUTIONS: PARAMETER INDUCTION APPROACH**

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Generalized distributions are modified probability distributions generated with the aim of improving flexibility and fitness to data. Generalized distributions obtained through the use of the same generalization method or generator are said to belong to the same class or family of generalized distributions. Study provides in details procedure of deriving these classes of generalized distributions using parameter induction method with emphasis on those introducing more than one new parameter. The Pareto distribution was used as base distribution to generate models belonging to each class of generalized distributions.

*Keywords: Generalized Distributions, Exponentiated Family, Marshall-Olkin Family, Alpha Power Transformed Family, Kumaraswamy-G Family*

**TIME SERIES ANALYSIS OF ENERGY GENERATED AND CORRESPONDING ENERGY CONSUMPTION BETWEEN 2010-2020 (A CASE STUDY OF NATIONAL CONTROL CENTRE (NCC), OSOGBO)**<sup>1</sup>Ajadi Akeem ; <sup>2</sup>Adeoye Akeem .O ; <sup>3</sup>Ojo Olufemi .D<sup>1</sup> University of Ilorin, Ilorin, Kwara State<sup>2</sup> Statistics Dept, Federal Polytechnic, Offa<sup>3</sup> Statistics Dept, Federal Polytechnic, Offa*Corresponding Author: dav.adeola@gmail.com*

The aim of this research is to examine the time series analysis of the energy generated and corresponding energy consumption in Nigeria. The specific objectives are to; describe the pattern of energy generated and corresponding energy consumption using time plot, determine the best model to fit the data and predict future energy generated and corresponding energy consumption using the appropriate model. The data used in this research work is a secondary data obtained from National Control Centre (NCC), Osogbo, Osun state. It covers energy generated and corresponding energy consumption in the control centre from 2010 to 2020. The methods employed in the analyzes of the data include time plot to describe the behaviour of the data, autocorrelation and partial autocorrelation plots to identify the possible structure of time series data and then residual plot to identify the desirable result in which the correlation is 0 between residuals separated by any given time span. The model found to be appropriate for fitting the energy generated and corresponding energy consumed is ARIMA(0,0,0) and for energy generated and ARIMA (0,0,7) for corresponding energy consumed. The study also revealed that there has been no major improvement in energy supply despite the year in year out increase in the budget for power from one government regime to the other. The government continues to spend huge sum of money on electricity but there is no corresponding improvement in the power sector. Therefore the researcher recommended that there should be proper monitoring in the money budgeted for power generation, transmission and distribution in Nigeria in order to see desirables results on the money spent and more power plants should be built as well as transmission stations.

*Keywords: Energy generation, Energy Consumption, ARIMA*

**TAX-REAL GDP RELATIONSHIP: TRADITIONAL TIME SERIES OR MULTIPLE LINEAR REGRESSION MODELS?**<sup>1</sup>Garba Mohammed Kabir<sup>1</sup> Department of Statistics, University of Ilorin*Corresponding Author: garbank@gmail.com*

In practice, virtually all forms of Gross Domestic Product (GDP), say GDP Per Capita, GDP growth, etc. are usually difference stationary series of order one  $\{I(1)\}$  except Real GDP which is often difference stationary series of order two  $\{I(2)\}$ . Besides, when there is at least an  $I(2)$  variable in a multivariate time series settings, the use of Traditional Multivariate Time Series (TMTS) or Multiple Linear Regression (MLR) techniques to investigate such time series is expected to yield spurious or misleading results. To shed light on this, this study therefore reviews the appropriate techniques for investigating the Tax-Real GDP relationship under mixed order of integrations such as  $I(2)$  and  $I(1)$ s respectively. Pre-examinations of the macroeconomic variables extracted from the Statistical Bulletin of the Central Bank of Nigeria (CBN) did not only confirmed that Real GDP ( $Ly_{1t}$ ), Company Income Tax ( $Ly_{2t}$ ), Petroleum Profit Tax ( $Ly_{3t}$ ), Personal Income Tax ( $Lx_{1t}$ ) and Value Added Tax ( $Lx_{2t}$ ) are not only  $I(2)$  and  $I(1)$ s but also affirmed that there is no two-way causation among  $Ly_{1t}$ ,  $Ly_{2t}$  and  $Ly_{3t}$ . The findings showed that despite the absence of simultaneity problem in the macroeconomic variables, the Three Stage Least Squares (3SLS) outperformed the Seemingly Unrelated Regression (SUR), OLS and Two-Stage Least Squares (2SLS) since it reported the least value of the standard errors of the regression parameters.

*Keywords: Tax, Real GDP, Multiple Linear Regression, Traditional Multivariate Time Series, Nigeria.*

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**ABSTRACT** In practice, virtually all forms of Gross Domestic Product (GDP), say GDP Per Capita, GDP growth, etc. are usually difference stationary series of order one  $I(1)$  except Real GDP which is often difference stationary series of order two  $I(2)$ . Besides, when there is at least an  $I(2)$  variable in a multivariate time series settings, the use of Traditional Multivariate Time Series (TMTS) or Multiple Linear Regression (MLR) techniques to investigate such time series is expected to yield spurious or misleading results. To shed light on this, this study therefore reviews the appropriate techniques for investigating the Tax-Real GDP relationship under mixed order of integrations such as  $I(2)$  and  $I(1)$ s respectively. Pre-examinations of the macroeconomic variables extracted from the Statistical Bulletin of the Central Bank of Nigeria (CBN) did not only confirmed that Real GDP ( $Ly_{1t}$ ), Company Income Tax ( $Ly_{2t}$ ), Petroleum Profit Tax ( $Ly_{3t}$ ), Personal Income Tax ( $Lx_{1t}$ ) and Value Added Tax ( $Lx_{2t}$ ) are not only  $I(2)$  and  $I(1)$ s but also affirmed that there is no two-way causation among  $Ly_{1t}$ ,  $Ly_{2t}$  and  $Ly_{3t}$ . The findings showed that despite the absence of simultaneity problem in the macroeconomic variables, the Three Stage Least Squares (3SLS) outperformed the Seemingly Unrelated Regression (SUR), OLS and Two-Stage Least Squares (2SLS) since it reported the least value of the standard errors of the regression parameters.

*Keywords: Tax, Real GDP, Multiple Linear Regression, Traditional Multivariate Time Series, Nigeria.*

**MODIFIED EXPONENTIATED NEW WEIGHTED RAYLEIGH DISTRIBUTION WITH APPLICATION**<sup>1</sup>Badmus Idowu<sup>1</sup> Department of Mathematics, University of Lagos, Akoka, Nigeria*Corresponding Author: idoscomus2011@gmail.com*

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**Abstract:** A three-parameter modified exponentiated new weighted Rayleigh distribution has been proposed from existing exponentiated new weighted Weibull distribution introduced by Elsherpieny et al. (2017). The modification is done by equating one of the parameters of the existing distribution to 2 due to the flexibility gain from the propose distribution. Several statistical properties of the target distribution are deriving and discuss. We apply a real life data set to illustrate the flexibility and potentiality of the distribution and the result reveals that the proposed distribution does better than other known and new distributions considered for the study.

*Keywords: Flexibility, Modified Exponentiated, Rayleigh, Weibull, Weighted*

**A MODIFIED GENERALIZED WEIGHTED RAYLEIGH DISTRIBUTION**<sup>1</sup>Badmus Idowu<sup>1</sup> Department of Mathematics, University of Lagos, Akoka, Nigeria*Corresponding Author: idoscomus2011@gmail.com*

Badmus, N. I<sup>1</sup>., Faweya, O<sup>2</sup> and Onyeka-Ubaka, J. N<sup>3</sup> <sup>1&3</sup>Department of Statistics, University of Lagos, Akoka, Nigeria  
<sup>2</sup>Department of Statistics, Ekiti State University, Ekiti State, Nigeria Corresponding Email: nibadmus@unilag.edu.ng Abstract A Modified generalized weighted Rayleigh distribution with some of its statistical properties is examined and presented using Topp Leone family of distributions. The modification was done by setting one of the parameters to two ( $\alpha=2$ ) to achieve the proposed distribution. We obtain several measures and order statistics of the proposed distribution. Also, maximum likelihood approach was used for estimation of model parameters. The strength of the proposed model was established using real life data set. The result showed that the modified distribution has better representation of the data set than any competing distribution weighed.

*Keywords: Order Statistics, Likelihood, Topp Leone, Weighted Rayleigh, Weighted Weibull*

**REINFORCEMENT LEARNING IN REPEATED TWO PLAYER GAMES: STATISTICAL ANALYSES OF OUTCOMES**<sup>1</sup>Okonkwo, S. J ; <sup>2</sup>Adedoyin, E. D.<sup>1</sup> Forestry Research Institute of Nigeria<sup>2</sup> Forestry Research Institute of Nigeria*Corresponding Author: sj.okonkwo@gmail.com*

This study uses a combination of Reinforcement Learning (RL), Game Theory, and Statistical Analysis to investigate the evolution of a Deep Q Network (DQN) agent as it interacts with opponents in a simulated two-player strategic setting. The simulated strategic setting is an iterative prisoner's dilemma with a problem of collective action where players have the options of cooperating for the collective good, or defecting for individual gain to detriment of the collective. There are three different scenarios. In the first scenario, the agent is pitted against an identical (imitating) DQN agent. In the second scenario, it is pitted against an initially cooperative but punitive opponent (Tit-for-Tat), and in the third scenario it is pitted against a completely indifferent opponent (Random). The actions and rewards of the players in each simulated scenarios were collected and statistically analyzed. Assessment of the average squared difference for the iterated rewards showed the second scenario (Agent vs. Tit-for-Tat opponent) as having the most consistently stable reward compared to the first (Agent vs. Identical DQN Agent) and third (Agent vs. Random Opponent) scenarios, with root mean square errors as 0.1983, 1.4840, and 1.2705 respectively.

*Keywords: DQN, Game Theory, Reinforcement Learning, RMSE*

**SURVIVAL ANALYSIS OF FIVE MONTHS ANNIVERSARY OF PATIENTS AFTER DIALYSIS**

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The mortality rate of kidney disease is increasing yearly and it has become a major burden. Despite, dialysis the challenge is still overwhelming. This study investigate five (5) months anniversary of patients after dialysis with kidney disease. Cox proportional model was used to determine anniversary periods of patients after dialysis in End-Stage Renal Disease. The hazard rate of kidney disease of the patient with hypertension, diabetes, kidney infection,severe malaria were statistically significantly with p-value of 0.000, 0.032, 0.002 and 0.010 respectively. The survival time of hypertension patients was between 21% to 49% at five months, the survival time of diabetes patients was between 6% to 29% at five months, that of acute kidney infection patients on dialysis lies between 21% to 46% and the survival time of severe malaria in kidney disease on dialysis patients was between 0 to 47% at five month .

*Keywords: Survival Analysis, dialysis, five month anniversary, kidney disease, cox proportion*

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*Keywords: Survival Analysis, dialysis, five month anniversary, kidney disease, cox proportion*

**EXPONENTIATED STANDARD RAYLEIGH PROBABILITY DISTRIBUTION**

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In this paper a new one parameter Exponentiated standard Rayleigh probability Distribution was proposed using Exponentiated family of distribution. The properties of the proposed distribution such as general moment, mean, standard deviation, skewness and kurtosis were derived. The proposed distribution was fitted on real life data set and compared with other existing distributions the results obtained shows that the proposed distribution performed better that the existing distributions.

*Keywords: "Rayleigh", "Exponential kurtosis", "Skewness", "Maximum likelihood"*

**FINITE MIXTURE MODELS FOR COUNT DATA: APPLICATION TO COVID-19 DATA IN SIX GEOPOLITICAL ZONES IN NIGERIA**

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The finite mixture distribution continues to receive more attention both in practice and theory due to its flexibility to model wide variety of random phenomenon. Count data emanating from unexplained heterogeneity cannot be modeled using traditional probability distribution (Poisson distribution). This variability is known as over-dispersion which can be tackled by Poisson-gamma(P-G) distribution and Generalized Poisson(GP). In some setting where counts include excess zeros, the P-G and GP are inadequate to account for the additional dispersion, so zero-inflated Poisson and zero-inflated negative binomial are proposed. Each of these two models assumes two-component mixture: the first standard distribution with a degenerate point-mass at zero and the other with non-degenerate count distribution. The aim of this study is to model data on COVID-19 in each of geopolitical zones in Nigerian. It has shown in literature the data consists of many zero counts. The parameters of the distributions were estimated using method of maximum likelihood. It was discovered that zero-inflated negative binomial outperformed the zero-inflated Poisson in four of the geopolitical zones using score test.

*Keywords: Finite mixture, count data, zero-inflated, score test, Covid-19*

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Abulkadir, S.S and Olumoh, J.S Abstract The finite mixture distribution continues to receive more attention both in practice and theory due to its flexibility to model wide variety of random phenomenon. Count data emanating from unexplained heterogeneity cannot be modeled using traditional probability distribution (Poisson distribution). This variability is known as over-dispersion which can be tackled by Poisson-gamma(P-G) distribution and Generalized Poisson(GP). In some setting where counts include excess zeros, the P-G and GP are inadequate to account for the additional dispersion, so zero-inflated Poisson and zero-inflated negative binomial are proposed. Each of these two models assumes two-component mixture: the first standard distribution with a degenerate point-mass at zero and the other with non-degenerate count distribution. The aim of this study is to model data on COVID-19 in each of geopolitical zones in Nigerian. It has shown in literature the data consists of many zero counts. The parameters of the distributions were estimated using method of maximum likelihood. It was discovered that zero-inflated negative binomial outperformed the zero-inflated Poisson in four of the geopolitical zones using score test.

*Keywords: Finite mixture, count data, zero-inflated, score test, Covid-19*



**INFLUENCE OF AGE AND BODY MASS INDEX (BMI) ON BLOOD PRESSURE USING MULTIPLE REGRESSION APPROACH**<sup>1</sup>KAROKATOSE GBENGA<sup>1</sup> YABA COLLEGE OF TECHNOLOGY, YABA, LAGOS.*Corresponding Author: gbenga.karokatose@yabatech.edu.ng*

Karokatose, G.B.1; Bamidele, G.I.2; Akintola, O.E.3; Karokatose, T.E.4 gbenga.karokatose@yabatech.edu.ng Department of Statistics<sup>1,2,3</sup>, Yaba College of Technology, Yaba, Lagos State, Nigeria. Department of Physics,<sup>4</sup> Osun State College of Education, Ilesa, Osun State, Nigeria.. Abstract Blood pressure: the force of circulating blood on the walls of the arteries. Blood pressure is taken using two measurements: systolic (measured when the heart beats, when blood pressure is at its highest) and diastolic (measured between heart beats, when blood pressure is at its lowest). Blood pressure is written with the systolic blood pressure first, followed by the diastolic blood pressure (for example 120/80). The only way to know if you have High Blood Pressure (HBP, or hypertension) is to have your blood pressure tested. The study aimed at determining the relationship of Age and Body Mass Index on Blood Pressure. The data used for this study was obtained from Solid Rock Hospital, Lagos State. People wondered if high blood pressure is a function of Age or the effect of Body Mass Index (BMI). A multiple regression analysis and Analysis of Variance (ANOVA) were adopted in the course of the study. The collected data were analysed using statistical package for social science (version 23). The result reveals that Age has significant relationship with systolic blood pressure and similarly BMI has relationship with systolic blood pressure since p-value is 0.016 ( $p < 0.05$ ). In a related development, the regression model (Systolic BP =  $104.820 + 0.091 \text{AGE} + 1.594 \text{BMI}$ ) showed that increase in age and BMI resulted in HBP. It is hereby concluded that there is a relationship between age and blood pressure and in addition, a relationship exists between BMI and blood pressure.

*Keywords: "Age", "Body Mass Index", "Blood Pressure".*

**ESTIMATION OF PARAMETERS OF SECOND-ORDER SPHERICAL DESIGNS USING CUBIC FUNCTION RELATIVE TO THE NON-SPHERICAL FACE CENTRED CCD FOR ALTERING AXIAL DISTANCES AND THEIR OPTIMALITIES**<sup>1</sup>Victor-Edema Uyodhu ; <sup>2</sup>ONU, Obineke Henry<sup>1</sup> Ignatius Ajuru University of Education Port Harcourt Rivers State<sup>2</sup> IAUE*Corresponding Author: peacevictor@yahoo.com*

The study presented the estimation of parameters of second order spherical designs using cubic model. Second order non-spherical face centred CCD were compared with second order spherical designs such as equiradial design of axial distances of 1.0 and 1.414, inscribed CCD of axial distance of 1.0 and circumscribed CCD of axial distance of 1.414, the study employed sum of square error, variance estimation, D-, A-, and T-optimality criteria as well as Grand mean of these designs for cubic model. The study considered the addition of centre points from 1 to 10 inclusive to each of these designs. It was observed that the sum of square error of the non-spherical face centred CCD is zero (0) for radial point of  $n=5$  with 1 centre point and this result is seen to be a misleading result, because, no process is 100%. While the sum of square error of the spherical designs with axial distance of 1.0 gave minimal sum of square errors and the spherical designs with axial distance of 1.414 gave very large sum of square error. Further, the Grand mean of the spherical and the non-spherical designs were approximately equal for radial point of  $n=5$  for centre points 1-10 inclusive., the Grand mean of the non-spherical CCD differs significantly from those of the spherical designs V. The study suggests that the non-spherical second order design is inferior to their spherical second order design counterparts. The spherical designs with axial distance of 1.414 (equiradial and circumscribed CCD) have better D-optimality, A-optimality and T-optimality than the non-spherical face centred CCD, while, the spherical designs with axial distance of 1.0 (equiradial and inscribed) has inferior D-optimality, A-optimality and T-optimality compared to the non-spherical face centred CCD with axial distance of 1.0.

*Keywords: "Spherical design", "Non-spherical design", "Equiradial design", "Central composite designs", "Cubic model."*

**INFLUENCE OF SOCIAL NETWORKING ON STUDENTS ACADEMIC PERFORMANCE IN SECONDARY SCHOOLS IN ILORIN SOUTH LGA**

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This research work examined the influence of social networking on student's academic performance in secondary schools in Ilorin South LGA, Kwara State. Five Research questions were use as a guide for the study. The descriptive survey research design was adopted. The study focused on students of Secondary Schools. The simple random sampling technique was used to select a sample of 200 students. A four point Likert Type Rating Scale Questionnaire type, titled: Effect of Social Media on Academic Performance of Students in Secondary Schools Questionnaire was used to collect data from the participants. The descriptive statistics of frequency counts and percentage, were used to analyze the data while inferential statistics of Chi-square(x<sup>2</sup>) was used in testing the research questions. The findings showed that a great number of students in Secondary Schools, are used to social media. It was revealed from the findings that usage of social media has significant influence on the academic performance of the students. Also, there is a significant influence on student's usages of social media network by age. Based on the findings it was recommended, that social media should be used for educational purposes as well; Social Networking Sites should be expanded and new pages should be created to enhance academic activities and avoid setbacks in the students' academic performance; and Students should be monitored by teachers and parents on how they use these sites. This is to create a balance between social media and academic activities of students to avoid setbacks in the academic performance of the students.

*Keywords: Keyboard: Social networking, Academic, Performance.*

**FORECASTING PERFORMANCE OF SELECTED UNIVARIATE TIME-SERIES TECHNIQUES FOR THE ANALYSIS OF INCIDENCE OF TUBERCULOSIS CASES IN AFIKPO NORTH L. G. A. EBONYI STATE.**

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Tuberculosis (TB) remains one of the world's deadliest infectious diseases, and still presents several difficulties, which requires strategies for immediate combat and intervention actions. Given that changes through the decision-making process are guided by current information, it is important for a country's public health managers to rely on accurate predictions that can detect the evolving incidence phenomena of TB. Thus, this study aims to determine the forecast accuracy of some selected univariate time series models for diagnosed TB cases in Afikpo North L.G.A., from January 2012 to December 2021, in order to ascertain which modeling technique that provides better performance. From this, data were collected from the in/out patients register of Mater Misericordiae Hospital Afikpo, which were submitted to Simple Exponential Smoothing (SES), Double Exponential Smoothing (DES), Holt-Winters Exponential Smoothing (HWES) and the Autoregressive Integrated Moving Average (ARIMA) model techniques. In the performance analysis and model selection, six criteria based on precision errors were established: Mean Square Error (MSE), Root Mean Square Error (RMSE), Mean Absolute Error (MAE), Mean Absolute Percent Error (MAPE), Theil's U statistic (U1 and U2). According to the results obtained, the HWES performed better compared to other techniques in relation to the error metrics, and therefore, recommended to be most accurate in making prediction for monthly incidence of TB cases in the study area

*Keywords: Forecasting, Holt-Winters, Tuberculosis, Time Series, Univariate Models*

**A NEW EFFICIENT ROBUST ESTIMATOR FOR LINEAR REGRESSION MODELS IN THE PRESENCE OF OUTLIERS**<sup>1</sup>Ibrahim, S.A. ; <sup>2</sup>Yahya W.B.<sup>1</sup> Al-Hikmah University, Ilorin<sup>2</sup> University of Ilorin*Corresponding Author: adeshinas2010@alhikmah.edu.ng*

In this study, a new robust-m-estimator for modelling linear regression in the presence of outliers was proposed through kernel function. The turning constant that determine its relative efficiency at 95% with reference to normal distribution was computed numerically. The efficiency was compared with some of the existing ones in the literature. Data were simulated from R statistical software at varying sample sizes  $n = (20, 75, \text{ and } 120)$ . The analyses were performed at 1000 replication to ensure models' stability. Absolute bias (ABS) and Mean Square Error (MSE) were used to assess efficiency as a statistical criterion. When data was generated from standard normal distribution (clean data). The results showed that the new robust-m-estimator was as efficient as least square at varying sample sized used. When data were contaminated with varying the percentage of outliers, the proposed estimator was more efficient in several situations. In conclusion, the newly proposed robust-m-estimator for outlier are therefore recommended to be used when outliers is the issue in multiple linear regression estimation.

*Keywords: Outliers, Robust regression, Simulation, ABS and MSE*

**A UNIFIED-GOMPERTZ MODEL FOR COVID-19 PANDEMIC IN KATSINA STATE**<sup>1</sup>Rabe Anasu<sup>1</sup> Department of Matematics and Statistics, Umaru Musa 'Yaradua University*Corresponding Author: anasu.rabe@umyu.edu.ng*

Understanding the dynamics (temporal or Spatial) of covid-19 in Katsina state provides useful information about the disease behavior that can be exploited in policy planning and developing strategies towards mitigating the disease. However, such descriptive information may not be sufficient when the aim is to predict the future behavior of the disease so as to develop strategies for its containment in the future. To fill this gap, we proposed a Unified-Gompertz (U-Gompertz) model to characterize the behavior of the disease and predict future positive cases in the state. A major advantage of the U-Gompertz model is that its growth rate parameter has a relative interpretation and can therefore be directly compared with the growth rates of other empirical models of the same family.

*Keywords: Covid-19, Relative growth rate, Transmission wave, U-Gompertz model*

### INVESTIGATING THE OPTIMALITY CRITERIA FOR A PARTIALLY BALANCED LATTICE DESIGN WITH TWO ASSOCIATE CLASSE

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Lattice designs is a class of incomplete block designs most commonly used in agricultural research. There is sufficient flexibility in the design to make its application simpler than most other incomplete block designs. The aim of this study is to investigate the design based optimality criteria of a two associate classes of a Partial Balance Lattice Design. The D, A, and E optimality criteria were studied. These approaches were demonstrated in our study involving nine treatments. We investigated the robustness properties of each of these optimal designs using their relative efficiencies. The results show that D-optimal has the highest values of 27, 729 and 19683 respectively for one replicate, two replicates and three replication designs, while A has 9, 18 and 27, and E has 3, 3, 3 although the designs. Considering the efficiency of the designs, in maximizing the information matrix, the results show that D, has 6.98 while A and E have 42.86 each. In minimized the dispersion matrix, the results show that D has 93.02 while A and E have 57.14 each. The results above showed that partial lattice design with one, two, and three balanced possess D optimality criteria which maximizes the information matrix. It is therefore recommended that an experimenter that chooses a Lattice design can do with a one or two or three replicated design without any loss of information

*Keywords: Lattice Square design, Associate classes, Optimality criteria, and Efficiency.*

### A COMPARATIVE STUDY OF SARIMA AND SARFIMA MODELS: AN APPLICATION TO SOLAR RADIATION

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The applications of dynamic models AR, MA or ARMA to time series data are very vital in our present society. In applying these models the stationarity condition of the dataset need to be considered, if the series is nonstationary then ARIMA model goes for such series. This work therefore focuses on comparing the fitness and predictive ability of SARIMA(p,d,q) (P,D,Q)<sub>12</sub> and SARFIMA(p,d,q) (P,D,Q)<sub>12</sub> models using monthly solar radiation data to investigate their stationarity, estimate the parameters, select the appropriate model of solar radiation and make forecasts for the two models. It well knows that solar radiation data as an environmental data are usually seasonal and sometime decays slowly to zero. Hence, the need to consider SARIMA(p,d,q) (P,D,Q)<sub>12</sub> and SARFIMA(p,d,q) (P,D,Q)<sub>12</sub> models. To our knowledge SARIMA(p,d,q) (P,D,Q)<sub>12</sub> and SARFIMA(p,d,q) (P,D,Q)<sub>12</sub> models are not been used to model solar radiation data. This study analyzed monthly solar radiation data in Uyo for 32years (1989-2020), Port Harcourt, Ibadan and Sokoto for 5years (2011-2015), respectively using SARIMA and SARFIMA models. Akaike Information Criteria (AIC) is the means used to examining the goodness of fit between the two models and root mean square error (RMSE), mean square error (MSE), mean absolute percentage error (MAPE) and mean absolute error (MAE) are used as forecasts performance measures. The model assessments AIC indicated that SARFIMA(p,d,q) (P,D,Q)<sub>12</sub> model has a better goodness of fit than SARIMA(p,d,q) (P,D,Q)<sub>12</sub> model in all the cities considered. The forecasts performance measures prove that SARIMA(p,d,q) (P,D,Q)<sub>12</sub> model has better predictive ability in Uyo, Port Harcourt and Sokoto than SARFIMA(p,d,q) (P,D,Q)<sub>12</sub> model with exception in Ibadan that SARFIMA(p,d,q) (P,D,Q)<sub>12</sub> model outperformed SARIMA(p,d,q) (P,D,Q)<sub>12</sub> model. Hence, the forecasts of monthly solar radiation in Uyo, Port Harcourt and Sokoto can be improved using SARIMA(p,d,q) (P,D,Q)<sub>12</sub> model while SARFIMA(p,d,q) (P,D,Q)<sub>12</sub> models improve in Ibadan on the basis of long memory dataset.

*Keywords: Solar Radiation, Seasonality, Long Memory, SARIMA, SARFIMA*

**SPATIO-TEMPORAL BAYESIAN MODEL WITH TWO-LEVEL SPATIAL STRUCTURED THAT INCLUDES COVARIATE EFFECT BASED ON MORTALITY RATE IN NIGERIA**

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Spatio-temporal disease mapping models suffer from the comparability problems of relative risks (RRs) based on the standardized mortality ratios (SMRs). The popularity of spatio-temporal modelling leads to the adoption of methods of calculating the mortality indicator to be depicted for a given disease. This paper proposed an alternative spatio-temporal Bayesian model with two-level spatial structured that includes covariate effect as the effect of the confounding factors on the RRs estimate in the study population based on mortality rate. The objective was to compare the results of depicting mortality indicators using the methods of calculating expected cases in spatio-temporal modelling context. The results show that, in general, the deviance information criterion (DIC) for the six spatio-temporal models considered, the method of expected-case computation using indirect method for a two-level model with second -level areas (SLAs) interaction overcome the single-level spatial models. And when it comes to visual comparison between a two-level model proposed by Ugarte et al (2016) and the proposed model as an alternative to the traditional use of SMRs, the two patterns did not differ substantially from the global map obtained with the usual SMRs and the maps generated for the entire period using age-adjusted mortality rates ratios as an alternative to the traditional use of SMRs.

*Keywords: Spatio-temporal modelling, Standardized mortality ratios, deviance information criterion, covariate effect, two-level spatial structure*

**STATISTICAL INVESTIGATION ON THE PREVALENCE OF PLASMODIUM SPECIES AMONG ADULTS IN NIGERIA**

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In 2020, nearly half of the world's population was at risk of malaria. Some population groups are at considerably higher risk of contracting malaria and developing severe disease: infants, children under 5 years of age, pregnant women and patients with HIV/AIDS, as well as people with low immunity moving to areas with intense malaria transmission such as migrant workers, mobile populations and travellers. According to the latest World malaria report, there were 241 million cases of malaria in 2020 compared to 227 million cases in 2019. The estimated number of malaria deaths stood at 627,000 in 2020 – an increase of 69,000 deaths over the previous year. While about two thirds of these deaths (47,000) were due to disruptions during the COVID-19 pandemic, the remaining one third of deaths (22,000) reflect a recent change in WHO's methodology for calculating malaria mortality (irrespective of COVID-19 disruptions). The new cause-of-death methodology was applied to 32 countries in sub-Saharan Africa that shoulder about 93% of all malaria deaths globally. Applying the methodology revealed that malaria has taken a considerably higher toll on African children every year since 2000 than previously thought. The WHO African Region continues to carry a disproportionately high share of the global malaria burden. In 2020 the Region was home to 95% of all malaria cases and 96% of deaths. Children under 5 years of age accounted for about 80% of all malaria deaths in the Region. Four African countries accounted for just over half of all malaria deaths worldwide: Nigeria (31.9%), the Democratic Republic of the Congo (13.2%), United Republic of Tanzania (4.1%) and Mozambique (3.8%).

*Keywords: Prevalence, plasmodium species, adults, Nigeria*

**ON AN AREA BIASED POISSON DISTRIBUTION WITH APPLICATIONS TO SOME INFECTIOUS DISEASES**<sup>1</sup>AMIRU FAISAL<sup>1</sup> BAYERO UNIVERSITY KANO*Corresponding Author: fmamiru.mth@buk.edu.ng*

ABSTRACT Practically, when observations from a sample are recorded with unequal probabilities proportional to some measure of unit size, some special class of weighted distribution called Size-biased distribution arises. In this paper, some Size Biased Poisson Distributions; Size-Biased Poisson, Size-Biased Poisson-Exponential and Size-Biased Poisson-Lindley distributions for modeling such observations were studied. The graphical nature and behaviour of the distributions were discussed. The properties of the distributions;  $r$ th factorial moments, first four moments about the origin and the first four moments about the mean were equally studied. The expressions for their coefficient of variation, skewness, kurtosis and index of dispersion were equally presented. The parameter of the distributions was estimated using the Maximum Likelihood Method and method of Moments. Their relative performances based on the Goodness-of-Fit (GoF) criteria were compared with that of Size Biased Poisson distribution on some real-life datasets. The GoF assessment of all the distributions was performed based on the values of their log-likelihoods, Akaike Information Criteria and Bayesian Information Criteria. The results showed that the distributions were relatively efficient for modelling the count datasets considered in the paper. The distributions are therefore recommended as credible alternatives for modelling observations recorded from a sample with unequal probabilities proportional to some measure of unit size.

*Keywords: Weighted Distributions, Poisson, Size Biased Poisson, Poisson-Exponential, Size Biased Poisson-Exponential, Poisson-Lindley, Size Biased Poisson-Lindley, Goodness-of-fit.*

**THE GENERALIZED FAMILY OF NORMALIZATION FOR SUPER-ADDITIVE GAME**<sup>1</sup>Chinonso Eze ; <sup>2</sup>Ugah Ejiofor<sup>1</sup> University of Nigeria Nsukka<sup>2</sup> University of Nigeria Nsukka*Corresponding Author: chinonso.eze@unn.edu.ng*

The concept of normalization in cooperative game theory so far, does not have a generalized family. In this work, we have been able to establish a generalized form of normalization that presents itself as a family to the existing forms. The procedure for the generalized form of normalization involves specifying the boundary parameters and estimating the transformation parameters through them such that the coalition worth of the generated game lies within the pre-specified boundary. This family of game normalization is flexible and applicable in all class of cooperative game. In addition, it observes transferable utility invariant property and retains inessential game property of the original game. Its application on a large game data shows how it shrinks the worth of coalitions to lie within pre-specified boundary.

*Keywords: cooperative game, game normalization, Rank-Shapley value*

**DETERMINANTS AND SPATIAL PATTERNS OF ANAEMIA AND HAEMOGLOBIN CONCENTRATION AMONG PREGNANT WOMEN IN NIGERIA USING STRUCTURED ADDITIVE REGRESSION MODELS**

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Anaemia which is a condition that describes low haemoglobin levels has been recognized as a major public health problem among pregnant women in many sub-Saharan African countries including Nigeria. The causes of maternal anaemia which are interconnected and complex vary between countries and can vary within a country. This study aimed to investigate the spatial pattern and identify demographic and socio-economic determinants associated with anaemia among Nigerian pregnant women aged 15-49 years using data from the 2018 Nigeria Demographic Health Survey. This study utilized chi-square tests of independence and semiparametric structured additive models to describe the relationship between the presumed factors and anaemia status or Hb level while also taking spatial effects at state level into account. The Gaussian and Binomial distributions were used for Hb level and anaemia status respectively. The overall observed prevalence of anaemia in pregnant women and average Hb level in Nigeria were 64% and 10.4 (SD = 1.6) g/dl respectively. Higher education, older age, and currently breastfeeding were associated with higher Hb level. Low education, being unemployed and recently having a sexually transmitted infection were identified as risk factors for maternal anaemia. Body mass index (BMI) and household size had a nonlinear effect on Hb level while BMI and age were nonlinearly related to odds of anaemia. Bivariate analysis indicated that living in rural area, low wealth class, using unsafe water and non-usage of internet were significantly associated with increased risk of anaemia. Maternal anaemia prevalence was highest in the South Eastern part of Nigeria with Imo state producing the highest prevalence of maternal anaemia while Cross River state yielded the lowest prevalence of maternal anaemia. The findings from this study can undoubtedly help in the planning and designing of anaemia interventions that match local conditions taking into consideration the aetiology of anaemia in Nigeria.

*Keywords: Maternal Anaemia, Maternal Nutrition, Iron deficiency, Geo-additive Models, Risk factors*

**SPATIAL PATTERNS, PREVALENCE AND DETERMINANTS OF CHILDHOOD STUNTING: A BAYESIAN GEOSTATISTICAL MODELLING APPROACH**

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Stunting is defined as "an impaired growth and development of children due to inadequate nutrition, repeated infections, and inadequate psychosocial stimulation. Child stunting, which is an indicator of chronic malnutrition among children, remains a significant public health issue in many developing countries including Nigeria and its prevalence exhibits considerable geographical variation. The aetiology of child stunting is complex and vary across different regions of the world and within countries. Bayesian geostatistical modelling was applied in this study to examine the prevalence and spatial pattern of stunting in Nigerian children less than five years considering anthropometric, socioeconomic and demographic risk factors. The data used for this study are from the 2018 Nigeria Demographic Health Survey. A binary logistic geostatistical model was fitted using the free BayesX software. The National observed prevalence of childhood stunting in Nigeria was 30%. Immunization, recent diarrhea status, mother's age, mother's height, mother's education level, gender of child, family wealth status, religion and geopolitical zone were identified as factors significantly associated with stunting. Lack of immunization, having diarrhea recently, low education, poor wealth status, being a female child and having a short mother were found to be associated with increased risk of stunting. Mother's age and child's age had a nonlinear relationship with odds of child stunting. Childhood stunting were more prevalent in the Northern regions especially the North-western and North-eastern part of Nigeria. The spatial effects consist of significant structured unstructured effects. The significant structured spatial effects indicate that the prevalence of childhood stunting is associated with some unobserved geographical and environmental factors that transcend boundaries of the states. The significant unstructured spatial effects suggest the prevalence of childhood stunting is influenced by some unobserved geographical and environmental factors that locations in close proximity do not have in common.

*Keywords: Child Nutrition, Spatial Distribution, Geo-additive Models, Risk factors, Children under 5 years*

**STATISICAL ANALYSIS ON THE EFFECT OF ROMANTIC RELATIONSHIP ON ACADEMIC PERFORMANCE OF STUDENTS IN YABA COLLEGE OF TECHNOLOGY**

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Academic performance is the degree to which a student accomplished their short or long term educational goals. The factors that contribute to academic success of students in their educational setting has been a topical issue as several works have been done by consideration of different variables with varied outcomes. The purpose of this study is to investigate the effect of romantic relationship on the academic performance of students. The hypothesis that romantic relationship between students in higher institutions of learning have effect on their academic performance was evaluated on final year students of Yaba College of Technology. The variables considered are relationship status of students, the number of times student attend lectures per week and Grade Point Average (GPA) which represents academic performance. The Data collection instrument (questionnaire) was administered to a total of 370 respondents selected by means of simple random sampling from eight stratum (schools) and analysis carried out with statistical tools such as frequency table, charts, cross-tabulation and Chi-Square test with the aid of SPSS Package. Findings showed that 76.0% of the respondents were in a relationship and that their status have no significant influence on the amount of time spent on studying ( $p > 0.05$ ) and no significance influence on the number of times student attend lectures per week ( $p > 0.05$ ). There was however significant association between students' relationship status and their attitude towards carrying-out their assignments/practical works ( $p < 0.05$ ). The study however found that there was no significant association between relationship status and academic performance ( $p > 0.05$ ). In conclusion, in order to have a successful academic life while maintaining a healthy romantic relationship, students should have good time management and try to maximize the positive effects of romantic relationship such as mutual support and personal growth.

*Keywords: "Romantic Relationship", "Academic Performance", "Tertiary Institution", "Grade Point Average", "Chi-Square Test"*



**PERFORMANCE COMPARISONS BETWEEN ARIMAX AND LOG-ARIMAX IN NON-NORMALITY DISTRIBUTION**

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In this paper, we find an efficient combining model in time series to capture the heavy-tailed properties of long-memory frequency observational time series data whose distributional forms are log-normal. This study shall propose a Log-ARIMAX model for time series data with heavy-tailed trait and to carry out a robust parameter estimation of the proposed model via Iterative Weighted Least Square (IWLS) Method. The study will also ascertain and compare the asymptotic property of the proposed model with ARIMAX via their stationarity and invertibility conditions and to compare the model performance of the proposed model with ARIMAX in terms of forecast indexes (MSE, AME, RMSE, ARMSE etc.)

*Keywords: Performance, Accuracy, Forecast, Time, Hybrid, Non-normality*

**COMPARATIVE ANALYSIS OF HOTELLING'S T SQUARE AND TWO-WAY ANOVA MODEL.**

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This paper is on the comparative analysis of Hotelling's T<sub>2</sub> distribution and Two-way analysis of variance without replication on the comparison between full-time and part-time student performance using the selected courses; Introduction to Statistics, Calculus, General Mathematics and Citizenship Education from 2018-2021. The precised aim of this paper is to find out whether there is a significant difference in the average performance of full-time and part-time taking a department operating both programme. The data were presented in a tabular form. The data were further analysed using the above-mentioned Statistical data analysis tools. From the Hotelling's T- Squared test. It was concluded that there is significant difference in the average performance of full-time and part-time students. On the other hand, the two-way analysis of variance indicates a significant difference in the performance of students based on courses and then gives no evidence to conclude that there is significant difference between the years under study.

*Keywords: Distribution, Partition, Statistic and Multivariate.*

**AN EXTENDED RAYLEIGH DISTRIBUTION: PROPERTIES AND ITS APPLICATIONS**

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A flexible four parameter extension of Rayleigh distribution is derived using the T-X method. The statistical properties of the new distribution such as the moments, quantile function, order statistics, entropy were examined. Maximum likelihood method of estimation is adopted in the estimation of the parameters of the new model. The usefulness of the new distribution is illustrated through its application to a real life datasets.

*Keywords: Rayleigh distribution, Moments, Order statistics, Quantile function, Maximum likelihood estimation*

**INVERSE GOMPERTZ DISTRIBUTION: PROPERTIES AND APPLICATIONS TO COMPLETE, TYPE-II RIGHT CENSORED AND UPPER RECORD DATA**

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This article studies the properties and application of two-parameter inverse Gompertz distribution and applications to upper record data. The main advantage of the new model is that it has "an upside-down bathtub-shaped curve hazard rate function depending upon the shape parameters. Several of its statistical and mathematical properties including quantiles, median, mode, moments, moment, entropy function, skewness, and kurtosis are derived. Moreover, the reliability and hazard rate functions. The maximum likelihood approach is used to estimate the new model parameters. Finally, the applicability of the proposed distribution is demonstrated with different engineering applications to complete, type-II right-censored, and upper record data. It is found that this model is more flexible when it is compared to well-known models in the statistical literature.

*Keywords: Inverse Gompertz, Type II right censored, Entropy function, Upper record data*

**MARKOV SWITCHING AUTOREGRESSIVE AND GARCH MODELS: A COMPARISON OF VOLATILITY MODELS WITH APPLICATIONS**

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This study explored and compared the Autoregressive models incorporating regime or Markov switching (RS-AR or MS-AR) Models with generalised autoregressive conditional heteroskedastic (GARCH) models. This stemmed from the dynamism and complexities observed in the volatility of economic phenomena the understanding of which will help in recommending better model fits. The models were applied to the all share index returns (ASIR) of the Nigeria stock exchange (NGX) and appropriate conclusions drawn based on the findings.

*Keywords: Autoregressive, Heteroskedastic, Markov Switching, Returns, Volatility*

**SOCIAL MEDIA AND VIOLENCE AMONG YOUNG PEOPLE IN YABA AREA, LAGOS STATE: A CHI-SQUARE INVESTIGATIONS**

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This study overviewed the effects of social media on violence among young people in Yaba area Lagos State. It identified the social media engaged in by youths, measured violent dispositions and the association between social media engagement and violence among the youths. Primary data collected by means of a questionnaire administered to 384 young persons conveniently sampled and selected from the study area was used in the study. Frequency distribution and Chi square were used in the analysis with the aid of SPSS 26. The results showed that the three mostly used social media among young people were WhatsApp (76.8%), Facebook (8.9%) and Instagram (7.8%) and 18.2% acknowledged that social media had negative effect on the users. The study also showed that males are twice more likely to engage in street fight, use of WhatsApp, Facebook, Twitter and Telegram are significantly associated with violence among young people ( $p < 0.05$ ). It was concluded that most of the youths believe that social media have a positive effect on the youths enhancing learning opportunities and healthy behaviour, social media also is associated with violence especially street fighting among young people.

*Keywords: Chi Square, Social media, Violence, WhatsApp, Young People*

**QUASI MAXIMUM LIKELIHOOD ESTIMATION OF NORMAL MIXTURE GARCH MODELS**

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Modelling and estimation of stylized facts in financial time series is a challenging task. The paper proposes the extended generalized autoregressive conditional heteroskedasticity (GARCH) families of models: exponential GARCH, GJR-GARCH and threshold GARCH via normal mixture GARCH models to capture the volatility dynamics in the export price of natural gas in Nigeria (2015-2021). The parameters of the selected models are achieved through the quasi maximum likelihood approach. The results show that the TGARCH-EGARCH mixtures outperformed other competing models in capturing the nonlinearities and tail-heaviness of the innovations distribution as evidenced from the model diagnostics. Importantly, the paper pinpoints that the proposed estimators are consistent and asymptotically normal under mild regular conditions.

*Keywords: Key words: "Volatility", "GARCH", "Asymmetric models", "Innovations", "Quasi Maximum Likelihood Estimation"*

**RISK OF MORTALITY IN PATIENTS WITH COMORBIDITIES AND COVID-19 IN SOME PARTS OF AFRICA**<sup>1</sup>Aren F. A. ; <sup>2</sup>Adehi M. U. ; <sup>3</sup>Audi N. I.<sup>1</sup> Nasarawa State University, Keffi<sup>2</sup> NASARAWA STATE UNIVERSITY KEFFI<sup>3</sup> Nasarawa State University, Keffi*Corresponding Author: maryadehi@yahoo.com*

One of the most conspicuous developmental challenge in Africa is the health and disease burden. Africa faces more health challenges compared to other regions in the world. This poses a threat to the economic development. The Covid-19 pandemic is projected to have one of its worst consequences in Africa especially in patients with comorbidities. The data for this research was sourced via google scholar, PubMed and Medline. A Meta-analysis was conducted with 8 studies and analyzed using the comprehensive Meta-analysis software. The resulting summary effect for the random effect was 1.886 at 95% confidence interval of (1.40,2.53), I-square =92.7%, (p-value =0.000). The result of this study favors mortality, therefore, implementation of adequate protection and interventions for covid-19 patients and particularly those with comorbidities may significantly reduce the risk of mortality associated with Covid-19.

*Keywords: Meta-analysis, Covid-19, Comorbidities, Mortality*

**ON THE CONSTRUCTION OF CONNECTED INCOMPLETE BLOCK DESIGNS FOR STATISTICAL EXPERIMENTAL LAYOUTS**<sup>1</sup>Ekpo Anthony<sup>1</sup> Department of Statistics, University of Agriculture, Makurdi, Benue State*Corresponding Author: tony21ng@yahoo.com*

In this study, seventeen (17) Incomplete Block Designs (IBDs) namely; designs G, H, I, J, K, L, M, N, O, P, Q, R, S, T, U, V and W constructed from the initial blocks due to Nguyen, (1994) via the cyclic method and JAVA codes are presented as an extension of the existing designs A-F. All the 17 IBDs were investigated for connectedness and thereafter categorized. The numbers of pairwise treatment connections in blocks were obtained and their concurrence graphs plotted for all the constructed IBDs. The study revealed that the newly constructed design Q, turned out to be better than Nguyen's designs A-F with 28 shorter paths and is closely followed by designs K, N, O, P, S, V and W with 27 shorter-paths each. Incidentally, Nguyen's design A turns out to be the least connected design among all the IBDs under consideration. The study concluded that the overall best design is design Q based on connectedness. The study recommends - designs Q for use with their experimental layouts by experimenters, investigators or evaluators who seek for the best optimal design of size  $t = 9$ ,  $b = 9$ ,  $k = 3$ ,  $r = 3$  in any field experiment based on connectedness. This experimental layout is equally recommended in the treatment plan of identified cases of Severe Acute Malnutrition (SAM), where nine feeding volumes (9) with three (3) replicate in a block size of three (3) in a Ready-to-use-therapeutic-feeding (RUTF) program is desirable.

*Keywords: Incomplete block design, pairwise treatment, concurrence graph, connectedness, incidence matrix.*

**APPROXIMATION RESULTS FOR SOLUTION OF STOCHASTIC HARD-SOFT CONSTRAINED CONVEX FEASIBILITY PROBLEM**

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In this work, a random-type iterative scheme is developed and used for random approximation of the solution of stochastic convex feasibility problem involving hard constraints (that must be satisfied) and soft constraints (whose proximity function is minimized) in Hilbert space. The iterative scheme is based on an alternating projection with Lipschitzian and firmly non-expansive mapping. Convergence results of the random-type iterative scheme to the solution of the stochastic convex feasibility problem are proved. These results extend, unify, and generalize different established deterministic results in the literature. \*1Akaninyene Udo Udom, 2Chijioke Joel Nweke. 1Department of Statistics, University of Nigeria Nsukka, Enugu State, Nigeria, 2Department of Mathematics and Statistics, Alex Ekwueme Federal University Ndufu-Alike, Ebonyi State, Nigeria.

*Keywords: hard and soft constraints, proximity function, random fixed-point, stochastic, firmly non-expansive.*

**MISSING OBSERVATION ROBUST DESIGNS**

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Missing observation occurs whenever a valid observation is not available for any one of the experimental unit, and is unavoidable even in a well-planned experiment. In this work, space-filling orthogonal-array based composite minimax loss designs were constructed using the minimax loss criterion to choose ? (the distance of a non-zero coordinate in an additional design point from the center) value that minimizes the maximum loss of one missing design point. The constructed designs were compared with some designs such as space-filling orthogonal-array based composite designs, orthogonal array composite minimax loss design, central composite design and small composite design based on the relative D-efficiency and the precision of regression coefficient estimates by calculating the generalized scaled standard deviations for full model, linear, quadratic, and bilinear terms respectively. The results showed that space-filling orthogonal-array based composite minimax loss designs performed better in some cases especially as the factors increases.

*Keywords: Missing observation, Space filling orthogonal-array based composite minimax loss design, D-efficiency, Regression coefficient, Generalized scaled standard deviations*

**ON OPTIMAL PRODUCT-MIX FOR PROFIT OPTIMIZATION OF SHARKS BREAD COMPANY**

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In this work, linear programming model was applied to Sharks bread Production Company to determine the right product-mix and quantities that maximize the company's daily profit. The data collected on the products and resources were analyzed. The result showed that 30 loaves of coconut, 411 loaves of fruit, 50 loaves of almond, and 270 loaves of wheat bread maximize the company's profit. Furthermore, the sensitivity analysis results showed the limits within which optimal profit of the company is maintained.

*Keywords: Product-mix, Optimal profit, Linear programming, Sensitivity analysis and Optimization*

**VOLATILITY MODELLING OF CRYPTOCURRENCY**

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Cryptocurrency has emerged as a form of digital currency that utilizes the advanced computer techniques. There has always been a great interest in learning about changes in the volatility patterns of financial market of which cryptocurrency is a part. This study examined the volatility persistence of selected cryptocurrencies termed shit coins and meme (WIN, BTT, SHIB, and Doge Coin) between the period of August, 2020 and July, 2021. The study seek to fit appropriate GARCH model to closing market returns and determine the best for each form of the underlying cryptocurrencies. The form of GARCH models explored were the standard GARCH, Asymmetric power GARCH, Exponential GARCH, Threshold GARCH and Integrated GARCH with maximum order of 2 under the normal, student t and generalized error distributions innovation. For the best model selection the Akaike and the Bayesian Information Criteria were used. The findings show that from the five sub-GARCH models fitted, EGARCH(1,1) with student t distribution innovation; EGARCH(2,2) with student t distribution innovation,; SGARCH(1,1) with student t distribution innovation and EGARCH(2,1) with generalized error distribution outperformed other models for BTT, WIN, SHIB and DOGE respectively attributed to their AIC and BIC. On the basis of the forecast performances measure, the smallest mean square error (MSE) and mean absolute error (MAE), it was discovered that EGARCH model has a better predictive ability for BTT, WIN, and DOGE coins while for SHIB was SGARCH. Hence, meme and shit coins are belongs indeed to the family of financial market since they possessed virtually all trait expected of the market. It is therefore of recommendation that financial market should be studied succinctly with techniques like the hidden Markov models that could help identify the hidden states of the currency at any point in state since such market are highly volatility and probability dependent.

*Keywords: Innovation, GARCH, Cryptocurrencies, Volatility.*

**ROBUSTNESS OF RANDOMIZATION TESTS FOR REPEATED MEASURES DESIGN**<sup>1</sup>John Obasi Ajali ; <sup>2</sup>Abimibola Victoria Oladugba ; <sup>3</sup>Oluchukwu Chukwuemeka Asogwa<sup>1</sup> University of Nigeria, Nsukka<sup>2</sup> University of Nigeria, Nsukka<sup>3</sup> Alex Ekwueme Federal University Ndufu Alike Ikwo*Corresponding Author: john.obasi.pg82810@unn.edu.ng*

Randomization tests (R-test) are often advocated as an alternative data analysis method when assumptions of most commonly used statistical techniques (such as analysis of variance, regression analysis, t-test, and analysis of covariance etc) are violated. In this work, the robustness in terms of empirical type I error and power (sensitivity) of R-test was evaluated and compared with that of F-test in the analysis of a single factor repeated measures design; when the data are normal, and non-normal with or without outliers under varied sample sizes and number of treatments. The Monte Carlo approach was used in the simulation study. The results showed that when the data are normal, the R-test was approximately as sensitive and robust as the F-test, while it was more sensitive than the F-test when data had skewed distributions. The R-test was more sensitive and robust than the F-test in the presence of an outlier.

*Keywords: Randomization test, Outlier, Type I error, Robustness, Power and Monte Carlo*

**IMPROVED RATIO ESTIMATORS OF POPULATION MEAN USING LINEAR COMBINATION OF AUXILIARY VARIABLE  
LOCATION PARAMETERS**

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In this study we proposed an improved family of ratio estimators for estimation of population mean using mixture of root of correlation coefficient, kurtosis, skewness and variance with maximum value of the auxiliary variable. The properties associated with the proposed estimators are assessed by mean square error (MSE) and compared with the existing estimators. From the empirical study, we observed the three proposed ratio estimators have least MSEs as compared with the MSEs for the latest existing ratio estimators. And the relative efficiency (RE) of all existing over proposed ratio estimators are greater than one (>1). By these, we concluded that the proposed estimators are more efficient than the existing estimators. Hence, we strongly recommend that our proposed estimators are preferred over the existing estimators in practical applications

*Keywords: : Auxiliary information, Mean Square Error, Related Efficiency*

**EFFECTS OF MISSING OBSERVATION ON PREDICTION VARIANCE OF ORTHOGONAL-ARRAY COMPOSITE DESIGNS**

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Orthogonal-Array Composite Designs (OACDs) are orthogonal composite designs that combine 2-level full or fractional factorial and 3-level orthogonal-array designs for estimation of the linear, bilinear, and quadratic effects in a second-order response surface model. In this work, the prediction variances of OACDs for 3 ? k ? 5 factors at different values of ? (the distance of a non-zero coordinate in an additional design point from the center) are examined in the presence of a single missing observation to ascertain the effect of one missing observation on these designs. The results showed a greater effect from missing observation when it occurs at the factorial and axial portions of these designs. Missing a center point has little or no effect.

*Keywords: Prediction variance, Orthogonal-array, Missing observation, Composite designs*

**BAYESIAN GENERALIZED LINEAR MIXED EFFECTS MODELS FOR CLUSTERED COUNT DATA USING THE T AND SKEW-T DISTRIBUTIONS**

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A standard assumption is that the random effects of Generalized Linear Mixed Effects Models (GLMMs) follow the normal distribution. However, this assumption has been found to be quite unrealistic and sometimes too restrictive as revealed in many real-life situations. A common case of departures from normality includes the presence of outliers leading to heavy-tailed distributed random effects. This work, therefore, aims to develop a robust GLMM framework by replacing the normality assumption on the random effects by the either the T or skew-T distributions. A full Bayesian technique via the Markov Chain Monte Carlo (MCMC) was adopted for estimation and inference. Simulation studies suggest situations where the T or skew-T distributions would be more appropriate for the random effects. A real-life data set on cotton bolls was used to demonstrate the application of the proposed methodology.

*Keywords: Repeated Measures, MCMC, Heavy tailed distribution, Skewed distribution, Student-t, Spatial effects, Posterior distribution*

**THE FIT OF MARGINAL REGRESSION MODEL FOR MIXED RESPONSE VARIABLES APPLIED ON MEASURE OF HOSPITAL PERFORMANCE**

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This study examines the marginal regression model for a mixed response variables (Normal-Poisson, Normal-Bernoulli as well as Poisson-Bernoulli). It adopts a generalized estimating equation (GEE) approach of model estimation. A frame work for mixed response variables was proposed and application to performance of hospital was carried out.

*Keywords: Marginal model, GEE, mixed response*



**ESTIMATION FOR VECTOR AUTOREGRESSIVE MODELS UNDER MULTIVARIATE SKEW-T-NORMAL INNOVATIONS**<sup>1</sup>Nduka Uchenna<sup>1</sup> University of Nigeria, Nsukka, Eunugu State, Nigeria*Corresponding Author: uchenna.nduka@unn.edu.ng*

Current procedures for estimating the parameters of  $p$ th order vector autoregressive (VAR(p)) model are usually based on assuming that the ensuing error distribution is multivariate normal. But there exists large body of evidence that several data encountered in real life are skewed; thereby making estimators derived based on normality assumption not suitable in such scenarios. This prompts for the search of appropriate methods for skewed distributions. Therefore, this paper proposes estimators for the mean and covariance matrices of the VAR(p) model under multivariate skew-t-normal (MSTN) distribution. Also, estimators for the shape and skewness parameters are provided. The expectation conditional maximization (ECM) and its extension the expectation conditional maximization either (ECME) algorithms are the tools used to derive the estimators. The performance of the estimators were examined through extensive simulations, and results show that they compete favourably with other numerical methods especially when the underlying distribution is skewed. The usefulness of our estimators were illustrated using a real data set from the New York Stock Exchange. The VAR(p) model under MSTN distribution provides a good fit, largely better than VAR(p) model under the assumption of normality.

*Keywords: ECM algorithm, ECME algorithm, Maximum likelihood estimation, Multivariate skew-t distribution*

**OUTLIER THIRD-ORDER RESPONSE SURFACE ROBUST DESIGNS**<sup>1</sup>Yankam Mbouamba Brenda ; <sup>2</sup>Abimibola Oladugba Victoria<sup>1</sup> University of Nigeria, Nsukka<sup>2</sup> University of Nigeria, Nsukka*Corresponding Author: brenda.yankam.pg03685@unn.edu.ng*

Outlier in an experiment can affect the results of a response surface design, and also impact negatively desirable properties of designs such as orthogonality, rotatability, and optimality. In this study, some new versions of augmented orthogonal uniform composite designs (AOUCDs) for fitting third-order response surface model are constructed using minimax outlying effect criterion. These constructed designs referred to as augmented orthogonal uniform composite minimax outlying (AOUCOs) designs are considered to be more robust to a single outlier. Based on the comparison with existing designs, these outlier third-order response surface robust designs are shown to be more optimal terms of the relative D- and G-efficiencies.

*Keywords: Augmented orthogonal uniform composite designs, Outlier, Minimax, D- and G-efficiencies.*

**COMPARATIVE ANALYSIS OF ESTIMATION TECHNIQUES ON THE EFFECT OF MACROECONOMIC INDICATORS ON GDP  
IN NIGERIA (2000 – 2020)**

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One of the methods used to overcome the problem of high dependency (Multicollinearity) among the explanatory variables when Ordinary Least Square (OLS) has been violated is known as Ridge Regression. A numerical example of Gross Domestic Products (GDP) and macroeconomic variables in Nigeria was employed using both methods to investigate the relationship of the variables in the presence of multicollinearity in the dataset. The source of data for this research paper could be traced to the Central Bank of Nigeria ([www.cbn.gov.ng](http://www.cbn.gov.ng)), the National Bureau of Statistics ([www.nigerianstat.gov.ng](http://www.nigerianstat.gov.ng)) and Trading Economics ([www.tradingeconomics.com](http://www.tradingeconomics.com)). The variables of interest are GDP, Money Supply, Exchange Rate and Inflation Rate. R package was used to perform the analysis for both linear and ridge regression and in turn proved the deficiency of ordinary linear regression and the sufficiency of ridge regression in relation to the problem of multicollinearity. The result showed that the ridge regression served as a remedial measure to the multicollinearity problem through the Variance Inflation Factor (VIF) quantities  $> 5$ .

*Keywords: Gross Domestic Products, Ordinary Least Square, Ridge Regression, Variance Inflation Factor*

**BAYESIAN: ON OVERCOMING NON-CONVERGENCE AND UNREALISTIC PARAMETER ESTIMATES IN ITEM RESPONSE  
MODELLING**

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Item response modelling is a theoretical frame work organised around the concept of latent traits. Estimation of more than two parameters in binary and multinomial item response modelling using maximum likelihood method may be difficult and produced unrealistic estimates due to non-convergence and high standard error of parameter estimates. Responses from 403 test takers were coded dichotomously and polytomously to illustrate our models with the aids of Stata 17SE on window platform. Bayesian binary item response modelling with prior and hyper-prior were used to overcome non-convergence while Bayesian multinomial modelling was developed using dcat function in Bayesian Inference Using Gibbs sampling to produce a more parsimonious estimates.

*Keywords: binary, multinomial, non-convergence, parsimonious, test, trait*

**ON TRANSMUTED INVERSE GOMPERTZ DISTRIBUTION: PROPERTIES, ESTIMATIONS AND APPLICATION**<sup>1</sup>Adegoke Taiwo ; <sup>2</sup>Obisesan K.O. ; <sup>3</sup>Oladoja O.M.<sup>1</sup> University of Ilorin, Kwara State<sup>2</sup> Department of Mathematics and Statistics, First Technical University, Ibadan<sup>3</sup> Department of Mathematics and Statistics, First Technical University, Ibadan*Corresponding Author: adegoketaiwom@hotmail.com*

In this paper, we propose a new three parameter distribution which is an extension of the inverse Gompertz distribution for modeling life time data called the "Transmuted Inverse Gompertz Distribution (TR-IGD)". The TR-IGD is obtained by using the quadratic rank transmutation map studied by Shaw et al. (2007) to develop a transmuted inverse Gompertz distribution. Some properties of the new TR-IGD distribution are considered. Seven different estimation techniques namely maximum likelihood estimate (MLE), Ordinary Least Squares Estimates (OLSE), Weighted Least Squares Estimates (WLSE), Crammer-Von Miss Estimate (CVME), Percentile estimate (PCE), Maximum Product Spacing Estimate (MPS) and Bayesian estimates (using different loss functions) are considered for the parameter estimation of TR-IGD. A Monte Carlo simulation study is carried out to examine the efficiency these parameter estimates. The usefulness of this new distribution is demonstrated with two (2) real data sets whose results shows that the new TR-IGD performs better than some familiar existing distribution.

*Keywords: Inverse Gompertz, Transmuted inverse gompertz distribution, Least Squares Estimates, Crammer-Von Miss Estimate, Monte Carlo simulation, Posterior distribution.*

**IMPROVED RATIO-CUM-PRODUCT ESTIMATOR FOR ESTIMATION OF FINITE POPULATION MEAN**<sup>1</sup>Muili Jamiu Olasunkanmi ; <sup>2</sup>Ahmed Audu ; <sup>3</sup>Ayodele Adebisi<sup>1</sup> Kebbi State University of Science and Technology Aliero<sup>2</sup> Usmanu Danfodiyo University Sokoto<sup>3</sup> Usmanu Danfodiyo University Sokoto*Corresponding Author: jamiunice@yahoo.com*

A ratio-cum-product estimator for estimating finite population mean of the study variable in simple random sampling without replacement (SRSWOR) have been suggested. The aim is to develop an efficient estimator in order to improve the precision of the estimate using information of auxiliary variable for both positive and negative correlations. The expressions of the bias and mean square error (MSE) of the suggested estimator is derived by Taylor's series method up to first degree of approximation. The efficiency conditions under which the proposed ratio-cum-product estimator is better than sample mean, product estimator, and other estimators considered in this study have been established. The numerical results shown that the suggested estimator is better and more efficient than the sample mean, product estimator and other existing estimators.

*Keywords: Product estimator, Finite Population, Auxiliary variable, and Population mean*

**SPATIO-TEMPORAL MODELLING OF SEVERITY OF MALNUTRITION AND ITS ASSOCIATED RISK FACTORS AMONG UNDER FIVE CHILDREN IN NIGERIA BETWEEN 2003 AND 2018**

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Malnutrition among under five children in Nigeria remains a major public health burden. It has been shown to be one of the leading causes of childhood death and has permanent consequences for cognitive development, school attendance, economic productivity in adulthood and maternal reproductive outcome. Understanding the associated risk factors of malnutrition is critical for developing appropriate interventions. Its determinants interact at different degrees to affect these children. Thus, it is important, for programmatic purposes, to continue to identify the important risk factors and geographical variations especially in a country with massive variations in cultural belief and socioeconomic status of its populace. In this paper, we explore spatio-temporal variations on severity of the three anthropometric indices among children under five in Nigeria using the Nigeria Demographic and Health survey data 2003 to 2018 using multilevel structured additive regression; based on cumulative probit link function. Within a Bayesian context, appropriate priors are assigned on all functions and parameters. Evidently, strong and significant spatial variations exist on severity of malnutrition among under five children in Nigeria showing a north-south divide. We found young age at first marriage, episodes of child illnesses, child birth weight, religion, mother's education and household wealth to be associated with undernutrition. Findings will guide in developing effective strategies to combat the devastating effect of child malnutrition in Nigeria. Consequently there can be hope of attaining the relevant sustainable development goals.

*Keywords: Anthropometric indices, Sustainable development goal, Structured additive regression, Markov chain Monte Carlo techniques.*

**BAYESIAN ANALYSIS OF TRANSMUTTED INVERSE RAYLEIGH DISTRIBUTION**

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In this paper, Bayes estimators of the unknown two parameters of the Transmuted Inverse Rayleigh Distribution (TIRD) have been derived using both the frequentist and Bayesian methods. The Bayes theorem was adopted to obtain the posterior distribution of the parameters of TIRD using both conjugate and non-conjugate prior distribution under different loss functions. The posterior distribution derived for the parameters are intractable and a Lindley approximation was adopted to obtain the parameters of interest. The loss function were employed to obtain the estimates for the parameters with an assumption that the parameters are unknown and independent. Also the Bayes estimate for the simulated datasets and real life datasets were obtained. The Bayes estimates obtained under different loss functions are close to the true parameter value of the shape and scale parameters. The estimators are then compared in terms of their Mean Square Error (MSE) using R programming language. We deduce that the MSE reduces as the sample size (n) increases.

*Keywords: Lindley's Approximation", Posterior Distribution", Prior Distribution", Loss Function"*

**ON THE USE OF RANDOM ITERATIVE SCHEME FOR STOCHASTIC APPROXIMATION RESULTS OF CONVEX FEASIBILITY PROBLEM**<sup>1</sup>Chijioke Joel Nweke ; <sup>2</sup>Akaninyene Udo Udom ; <sup>3</sup>George Chinanu Mbaeyi<sup>1</sup> Alex Ekwueme Federal University, Ndufu-Alike, Ebonyi State, Nigeria.<sup>2</sup> University of Nigeria Nsukka<sup>3</sup> Alex Ekwueme Federal University Ndufu-Alike*Corresponding Author: cj\_nweke@yahoo.com*

A stochastic equivalent of strong convergence results of convex feasibility problem using random cyclic projection algorithm was presented in this study. The convergence to a random fixed-point becomes necessary considering the probabilistic nature of a system influenced by random perturbation. It has also proved that the solution of the stated optimization problem generated by random-typed iterative scheme converges in quadratic mean, consequently in probability to random fixed-point. These results extend different established deterministic results in the literature for convex feasibility problem.

*Keywords: stochastic convergence, random iterative scheme, non-expansive operator and convex feasibility problem*

**A RETROSPECTIVE EVALUATION OF TEMPERATURE MEASUREMENT WITH A NON-CONTACT INFRARED DIGITAL THERMOMETER AS A PROCEDURE FOR COVID-19 INFECTION CONTROL**<sup>1</sup>Kazeem Adewale Osuolale ; <sup>2</sup>Babatunde Adewale ; <sup>3</sup>Raheem Toyosi ; <sup>4</sup>Lawal Dayo Quzeem ; <sup>5</sup>ADESOLA MUSA ; <sup>6</sup>Oliver Ezechi<sup>1</sup> NIGERIAN INSTITUTE OF MEDICAL RESEARCH, YABA LAGOS NIGERIA.<sup>2</sup> NIGERIAN INSTITUTE OF MEDICAL RESEARCH, YABA LAGOS NIGERIA.<sup>3</sup> NIGERIAN INSTITUTE OF MEDICAL RESEARCH, YABA LAGOS NIGERIA.<sup>4</sup> Federal University of Agriculture, Abeokuta<sup>5</sup> NIGERIAN INSTITUTE OF MEDICAL RESEARCH, YABA LAGOS NIGERIA.<sup>6</sup> NIGERIAN INSTITUTE OF MEDICAL RESEARCH, YABA LAGOS NIGERIA.*Corresponding Author: dayoquzeem@yahoo.com*

The emergence of coronavirus disease in December 2019 is a major global health concern considering high body temperature as one of the symptoms of COVID-19 and avoidance of close contact due to the nature of the virus. This study evaluates temperature measurement with a non-contact infrared digital thermometer during COVID-19 pandemic. Logistic regression model was used for inferential analysis. This study is a cross-sectional design that utilized data obtained from a study conducted between 31 March 2020 and 30 April 2020 at the Nigerian Institute of Medical Research, Lagos. Among 2160 participants, 1147 (53.1%) were females and 1013 (46.9%) were males. Of these, 69 (3.2%) were positive to SARS-CoV-2, five (7.2%) participants had elevated body temperature while 64 (92.8%) participants had normal body temperature. The odds of having a normal temperature to detect SARS-CoV-2 was 1.5 times higher for female participants though gender did not significantly affect body temperature ( $p > 0.05$ ). Age has a significant effect on the temperature status of the participants ( $p < 0.05$ ). The odds of having a normal body temperature to detect SARS-CoV-2 was 0.34 times lower for participants  $\geq 49$  years. Mode of transportation has a significant effect on the temperature status of the participants ( $p < 0.05$ ). The odds of having a normal body temperature to detect SARS-CoV-2 was 2.26 times higher for participants that walked to the testing centre. The COVID status has a significant effect on the temperature of the participants ( $p < 0.05$ ). The odds of having a normal body temperature was 3.33 times higher for participants with negative result of SARS-CoV-2. This study re-affirms that asymptomatic transmission plays a role in the overall incidence of COVID-19. Therefore, anybody entering a public place even with normal body temperature were made to comply with non-pharmaceutical interventions as an infection control measure. These findings are in line with findings in other studies during COVID-19 outbreak in Nigeria.

*Keywords: COVID-19, temperature, infrared digital thermometer, odds, inferential analysis*

**TIME SERIES ANALYSIS OF ENERGY GENERATED AND CORRESPONDING ENERGY CONSUMPTION BETWEEN 2010-2020 (A CASE STUDY OF NATIONAL CONTROL CENTRE (NCC), OSOGBO**

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TIME SERIES ANALYSIS OF ENERGY GENERATED AND CORRESPONDING ENERGY CONSUMPTION BETWEEN 2010-2020 (A case study of National Control Centre (NCC), Osogbo) Abstract The aim of this research is to examine the time series analysis of the energy generated and corresponding energy consumption in Nigeria. The specific objectives are to; describe the pattern of energy generated and corresponding energy consumption using time plot, determine the best model to fit the data and predict future energy generated and corresponding energy consumption using the appropriate model. The data used in this research work is a secondary data obtained from National Control Centre (NCC), Osogbo, Osun state. It covers energy generated and corresponding energy consumption in the control centre from 2010 to 2020. The methods employed in the analyzes of the data include time plot to describe the behaviour of the data, autocorrelation and partial autocorrelation plots to identify the possible structure of time series data and then residual plot to identify the desirable result in which the correlation is 0 between residuals separated by any given time span. The model found to be appropriate for fitting the energy generated and corresponding energy consumed is ARIMA(0,0,0) and for energy generated and ARIMA (0,0,7) for corresponding energy consumed. The study also revealed that there has been no major improvement in energy supply despite the year in year out increase in the budget for power from one government regime to the other. The government continues to spend huge sum of money on electricity but there is no corresponding improvement in the power sector. Therefore the researcher recommended that there should be proper monitoring in the money budgeted for power generation, transmission and distribution in Nigeria in order to see desirables

*Keywords: Energy generated, energy consumed, ARIMA*

**MODELLING THE IMPACT OF POST COVID-19 PANDEMIC ON THE PERFORMANCE OF NIGERIA STOCK EXCHANGE USING GARCH DISTRIBUTION**

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The unprecedented COVID-19 epidemic has put the world in peril and shifted the global landscape in unanticipated ways. Using the GARCH distribution, this study investigates the impact of the post-COVID-19 pandemic on the performance of the Nigeria Stock Exchange (NSE) index return from January 2016 to April 2022. The ARCH effect statistic utilizing the ADF statistic reveals the presence of heteroscedasticity, while the stationarity statistic indicates that data is stationary without transformation. The volatility models were found to be statistically significant, with probability values of 0.01 for the distributions. The results reveal that GARCH(1,1) with a normal error distributions outperforms other volatility models and error distributions, and has the lowest AIC. The normal error distribution outperforms the students t and generalised error distributions in term of best fit. Furthermore, the whole sample forecast reviews that the NSE return is stable but volatile. Volatility is likely to occur in the first four months of the year 2022, while the estimate on a smaller sample size is also stable with volatility slows toward April 2022.

*Keywords: Volatility Models, Error distributions, Forecast, Stock Exchange, COVID -19*

**IDENTIFICATION OF MOBILE PHONE BRANDS BASED ON PHONE FEATURES – DISCRIMINANT ANALYSIS PERSPECTIVE**<sup>1</sup>Olusola Samuel Makinde ; <sup>2</sup>Jumoke Popoola ; <sup>3</sup>Paul Alexander Otulaja<sup>1</sup> Department of Statistics, The Federal University of Technology, P.M.B 704, Akure, Nigeria<sup>2</sup> Department of Statistics, University of Ilorin, Ilorin, Nigeria. Nigeria<sup>3</sup> Department of Statistics, The Federal University of Technology, P.M.B 704, Akure, Nigeria*Corresponding Author: jmkbalpop@unilorin.edu.ng*

Abstract A common question in information and technology section is whether a mobile phone brand can be determined by features they possess. In differentiating between mobile phone brands, phone features as well as other information around can be used to build discriminant functions to carry out the task. In this paper, two classification methods were employed to determine the class (mobile phone brands) a set of features belongs. The classification methods are linear discriminant analysis and quadratic discriminant analysis. The performances of these methods were examined by the estimates of their probabilities of correct classification. Quadratic discriminant analysis was found to have the highest classification power. However, its power will be improved if more features were added to the data and sample size of each brand increased.

*Keywords: Classification", probability", mobile phone brands", multivariate outcomes", discriminant analysis".*

**MODELING OVER AND UNDER DISPERSED COUNT DATA USING CONWAY-MAXWELL-POISSON DISTRIBUTIONS**<sup>1</sup>Idowu Afolabi ; <sup>2</sup>W.B. Yahya<sup>1</sup> Department of Mathematics and Statistics, Kwara State University, Ilorin<sup>2</sup> Department of Statistics, University of Ilorin*Corresponding Author: divinegrtness02@yahoo.com*

This study considered Conway-Maxwell-Poisson-Negative- Binomial (CPNB), Generalized-Conway-Maxwell Poisson (GCP), and the Extended-Conway-Maxwell Poisson (ECP) distributions for modeling data exhibiting over- and under- dispersion and made a comparison with some classical distributions. Three count data sets were used with one exhibiting under-dispersion. The maximum likelihood method was used for parameter estimation. Different general-purpose optimizers were adopted in R to confirm the consistency and accuracy of parameter estimates. Theoretical means and variances of the models were generated with their corresponding empirical means and variances. It was discovered that both do not unit for each of the data examined because all models have a range of infinite values that exceed the range of the random variable. Consequently, the sum of estimated probabilities does not add up to one and the sum of the expected values is less than the sample size. R general-purpose optimizer was used with the Newton Raphson algorithm being the choice optimizer. The Wald test statistic for all models was computed based on both the theoretical and empirical means and variances. The results obtained from this study are consistent with previous analyses of the data sets and produce significant improvement.

*Keywords: Com-Poisson, over-dispersion, empirical variance, empirical mean*

**STATISTICAL SURVEY OF THE KNOWLEDGE, ATTITUDE AND PERCEPTION TOWARDS COVID 19 VACCINATION AMONG TERTIARY STUDENTS IN LAGOS STATE, NIGERIA.**

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The COVID-19 virus dealt a major health crisis to the world between late 2019 and early 2022 and Nigeria inclusive. The pandemic posed different challenges to several countries. Nigeria with a high youth population is at risk of being overwhelmed by the virus. With respect to this, it is important to understand the general reception of young Nigerians towards the virus. A higher institution in the most populous city in the country Yaba College of Technology presents a good case study. The instrument of data collection was the questionnaire and the sampling technique employed for data collection was the stratified sampling technique. Friedman Test was used to examine whether the students are well informed about Covid-19 vaccine, whether the students have positive attitude towards the vaccine and the student perspective about the vaccine. The result shows that there is enough information, positive attitude and good perspective on the side of the students with a p-value of 0.000 Keywords: COVID-19, Public health, Perception, vaccination, Friedman test

*Keywords: Keywords: COVID-19, Public health, Perception, Vaccination, Friedman test*

**EVALUATION OF (6X6)/2 SEMI-LATIN SQUARES**

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In this paper, we evaluated a set of six (6) designs from Bailey and Royle (1997) by constructing the Variety Concurrence graphs of these designs and performing the number of shortest circuit criterion. The designs are already efficient using A, D, E and E' Optimality criteria. This paper explains why numbers of circuits in the variety concurrence graph of a design provide an attractive measure of its efficiency. A semi-Latin square is an allocation of nk treatments to the plots of such an array so that each treatment occurs once in each row and once in each column. In this paper we therefore examine (6 x 6)/2 semi Latin squares. We restrict attention to those semi-Latin squares whose quotient block designs are regular-graph designs, because a plausible and widely believed conjecture is that optimal regular-graph designs are optimal overall. We find that all these designs are almost equally efficient with respect to the criterion used.

*Keywords: circuit, variance dispersion graph, semi-latin square*



**LOGARITHMIC-TYPE RATIO ESTIMATOR FOR ESTIMATION OF FINITE POPULATION MEAN**<sup>1</sup>Muili Jamiu Olasunkanmi ; <sup>2</sup>Ahmed Audu ; <sup>3</sup>Mojeed Abiodun Yunusa<sup>1</sup> Kebbi State University of Science and Technology Aliero<sup>2</sup> Usmanu Danfodiyo University Sokoto<sup>3</sup> Usmanu Danfodiyo University Sokoto*Corresponding Author: jamiunice@yahoo.com*

Logarithm is the inverse function to exponentiation. In this paper a logarithmic-type ratio estimator is suggested for estimating finite population mean of characteristic under study. Taylor series approximation was used up to first order approximation in derivation of bias and mean square error. Theoretically, the bias and mean square error equations of the suggested estimator are obtained and then compared with the finding which are supported by numerical illustration using real dataset. The results revealed that the suggested estimator is more efficient than other existing estimators considered in the study.

*Keywords: Logarithmic ratio estimator, Auxiliary variable, Efficiency, Mean square error.*

**FRECHET-DAGUM-Y DISTRIBUTION: PROPERTIES AND APPLICATIONS**<sup>1</sup>Matthew Iwada Ekum ; <sup>2</sup>Adeyinka Solomon OGUNSANYA ; <sup>3</sup>Joseph Adekunle AKINYEMI ; <sup>4</sup>Olumide Ajala ; <sup>5</sup>Olatunji Taofik Arowolo<sup>1</sup> Department of Mathematical Science, Lagos State University of Science and Technology, Ikorodu, Lagos, Nigeria<sup>2</sup> Department of Statistics, University of Ilorin, Ilorin, Kwara State, Nigeria<sup>3</sup> Department of Mathematical Science, Lagos State University of Science and Technology, Ikorodu, Lagos, Nigeria<sup>4</sup> Department of Mathematical Science, Lagos State University of Science and Technology, Ikorodu, Lagos, Nigeria<sup>5</sup> Department of Mathematical Science, Lagos State University of Science and Technology, Ikorodu, Lagos, Nigeria*Corresponding Author: matekum@yahoo.com*

Recently, the T-Dagum family was proposed using the T-R{Y} framework. The Frechet distribution is useful in extreme events such as annually maximum one-day rainfalls, river discharges and oil or gas production rate over time for a well. The Dagum distribution is another useful distribution in modelling personal income, wealth distribution and Gini index. The hybrid of these two distributions using Lomax quantile function would be very useful in real applications, especially with skewed bimodal data. In this study, a new distribution called Frechet-Dagum using Lomax quantile function is proposed, where the T is Frechet and Y is Lomax, and subsequently other distributions can be used as Y to generate new distributions. The hybrid distribution is the combination of the strength of the three distributions. The new generated distribution would have more parameters but would have higher flexibility in handling bimodality in datasets and it is a weighted hazard function of the baseline distribution. Thus, would be useful in survival analysis. Different characterizations and properties of the proposed distribution were derived. The maximum likelihood function was used to estimate the parameters of the distribution. Simulation study was carried out to test the consistency of the parameters estimated. Real data were used to show its usefulness and its results compared favourably with existing related distributions in literature. The proposed distribution would be used in areas where Frechet or Dagum distributions are not good fit to the data of interest.

*Keywords: Bimodal, Frechet, Lomax, Quantile Function, T-Dagum*

**MODELLING INFLATION IN PRICE OF FOOD ITEMS USING DYNAMIC REGRESSION APPROACH**<sup>1</sup>Olusola Samuel Makinde ; <sup>2</sup>Jumoke Popoola ; <sup>3</sup>Kabeerat Oyerolake Animasaun<sup>1</sup> Department of Statistics, The Federal University of Technology, P.M.B 704, Akure, Nigeria<sup>2</sup> Department of Statistics, University of Ilorin, Ilorin, Nigeria. Nigeria<sup>3</sup> Department of Statistics, The Federal University of Technology, P.M.B 704, Akure, Nigeria*Corresponding Author: jmkbalpop@unilorin.edu.ng*

Abstract In econometrics, there is often need to predict for future purposely to plan. Some variables can be predicted from others if there is relationship between them. Regression analysis can be used to predict future value of a variable using other variables. However, in classical linear regression analysis one of assumptions that must be met is that the error term must be random, that is the error term must not be autocorrelated. In econometrics, while using time series data, this assumption is often violated then the classical linear model is no longer the best tool for predicting. Then there is need to manage the situation. In this study, consumer price index (CPI) of food item was predicted using the CPI of alcohol, clothing, housing, furniture, health, transportation and education as predictor variables. Due to the serial nature of the data, CPIs of food items are autocorrelated, which made classical linear regression model not a good tool for predicting price of food. Dynamic regression model was fitted to the data. The fitted values of dynamic regression model were compared with observed values to check whether the model fits food price well. This was supported by the value of the coefficient of determination.

*Keywords: "Consumer price index", "dynamic model", "autocorrelated errors", "R2", "food items".*

**ANALYSING NON-LINEAR RELATIONSHIPS USING SPLINE REGRESSION MODEL**<sup>1</sup>AJAO ISAAC<sup>1</sup> Department of Mathematics and Statistics, Federal Polytechnic, Ado-Ekiti, Ekiti state*Corresponding Author: softdataconsult@gmail.com*

There have been a lot of errors committed in analyzing datasets such as economic, medical, weather, and so on which do not have linear structure that have been wrongly analysed by using linear models, this has led to misspecification of models in many cases and of course wrong results and predictions. This paper therefore seeks to address this issue by recommending spline models using a non-linear simulated dataset. Results show that spline models is better than the conventional linear regression model (LRM), Generalized additive model (GAM), Polynomial models, and log-transformed model with minimum values from AIC = 82.6670, BIC = 139.8760, RMSE = 0.2502, MSE = 0.0626, and MAE = 0.1815 and maximum from R2 = 0.8129. These suggest that the spline regression model out-performs the other models when handling non-linear data and therefore recommended.

*Keywords: Spline, GAM, non-linear, predictions, models*

**CHANGE POINT DETECTION USING MOVING INDEX: THE EFFECT OF REGIME CHANGE ON PETROLEUM PRICE IN NIGERIA**

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Persistent instability of crude oil prices in the global market has adversely affected all the sectors of Nigerian economy. The prices of petroleum products were reviewed more than ten times between 1990 and 2016. The adjustment in 2000 under the democratically elected government marked a turning point in the economy as petrol moved up to N30 per litre. Almost every change in government regime has a regime change in petroleum price. This research study the effect of change in government regime on change in petroleum price using moving index with a constant and moving base year. Data on prices of petroleum were collected from 1960 to 2021, spanning 62 years, and the changes in these prices over all the regime were observed via the time plot. The moving index with constant and varying base year were used for the analysis. The results of the analysis showed that regime change in Nigeria has impacted so much on the price of petroleum. The trend of change in petroleum prices using 1960 as a constant base year showed that regime change has significant effect on change in petroleum price, while the moving index with varying base year showed no significant effect on the change in the petroleum price. Thus, it is concluded that the changes in price of petroleum in Nigeria is not as a result of the change in regime, only but also as a result in change in time. The estimated trend of change in the prices of petroleum with the period under study showed an upward trend. The movement showed that price of petroleum is not likely to reduce in the nearest future but rather will increase if nothing is done to stabilize it.

*Keywords: "Change Point," "Moving Index," "Non-Linear," "Petroleum Price," "Regime Change"*

**EFFECT OF MONETARY POLICY ON THE NIGERIAN STOCK MARKET USING GENERALIZED ADDITIVE MODEL FOR LOCATION, SCALE AND SHAPE**

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This study examined the effect of monetary policy on the Nigerian stock market performance in Nigeria for the period 2006– 2020. The technique employed was Generalized Additive Model using Location, Scale and Shape (GAMLSS) which is as an extension of the Linear Model (LM), Generalized Linear Models (GLM) and Generalized Additive Models (GAM). The Nigerian Stock Exchange All Share Index was the proxy for the dependent variable. Monetary policy was measured by money supply, interest rate, exchange rate and inflation rate as the independent variables. The GAMLSS family continuous distributions in the positive real line were fitted into the data in order to select the best fitted model. The result of the AIC and BIC show that the Generalized Gamma (GG) distribution best fit the response variable, hence, GG regression model was used to examine the effect of monetary policy on the Nigerian Stock Market. The findings of the study show that the money supply and exchange rate have a positive relationship on monetary policy while interest rate and inflation rate have a negative relationship on monetary policy. Only the inflation rate has a significant effect on Nigerian Stock Market.

*Keywords: All Share Index, GAMLSS, Generalized Gamma distribution, Monetary policy, Stock Market.*

**ON ASSESSING THE SUPERIORITY OF A HYBRID ARIMA AND FEED FORWARD ANN MODEL OVER A CLASSICAL ARIMA MODEL.**

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Inflation data of any country is a measure or indicator of stability of such country, a high inflation rates may spell doom for such nation and a such all known method(s) must be used to guide against it. Literatures have established the superiority of a Hybrid Autoregressive Integrated Moving Average (ARIMA) and feed forward Artificial Neural Network (ANN) model over classical model. It is therefore the focus of the present study to establish the veracity of this claim as applied to inflation rates data of Federal Republic of Nigeria. The Box-Jenkins methodology was employed to fit the ARIMA model while the feed-forward Neural Network Autoregressive (FFNNAR) structure was fitted using the neural network portion of the hybrid model. The stationarity of the series was established using Augmented Dickey Fuller Tests, Graphical and Units roots test. Stationarity of the series was achieved at first difference. So also, the mathematical framework was established for all the models used. The results obtained show that the ANN-ARIMA model out-performed ARIMA (2,1, 2) model fitted for the data on Nigerian inflation rate data. The Root Mean Squared Error (RMSE) value obtained show that ANN-ARIMA slightly out-performed ARIMA model. The ANN-ARIMA forecasts outperform the ARIMA forecasts by almost 18% on the same basis. conclusively, the Hybrid model has enormous potential compare to classical ARIMA model, the study therefore, confirms what was known in the literature. It should be noted that computational cost of ANN-ARIMA is on the high side compare to classical ARIMA model.

*Keywords: ARIMA, ANN, FFNNAR, ANN-ARIMA inflation, and RMSE*

**ON CO INTEGRATION ANALYSIS OF RELATIONSHIP BETWEEN GDP AND SOME GOVERNMENT EXPENDITURES**

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This study investigates the existence of causal relationship between some government expenditure and economic growth in a developing economy like Nigeria. The government expenditures studied are agriculture, telecommunication, wholesaler and retailer and Gross domestic product. The scope of this study spans from the year 1990 to 2019. The raw data were first subjected to some stationary test using the graphical and Augmented Dickey Fuller methods. The results show non-stationary for all the raw data. Thereafter Data transformation was carried out using natural logarithm. After this, the series eventually became stationary. Johansen cointegration test transformation on the variable resulted in cointegration between Agriculture, Crude oil and gas, wholesaler and retailer, telecommunication spending and GDP. The finding imply that the ever-rising economic profile of Nigeria is having effect on government expenditure in both short and long run.

*Keywords: Cointegration, expenditure, Stationarity, transformation, Economic growth and Causal relationship*

**AN OVERVIEW OF REGRESSION DIAGNOSTIC PLOTS**

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In fitting a regression model, it is useful to check diagnostic plot to assess the quality of the fit. Therefore, Diagnostic plots such as residual, normal probability plots among others are often used to investigate the condition of the model. However, these plots are not reliable as their performance varies with the sample sizes. This study intends to investigate behavior of diagnostic plot given different scenario of samples. In the end, suggestion will be in accordance with empirical evidences on the use of diagnostic plots.

*Keywords: Regression Model, Diagnostic Plots, Residual Plot, Normal Probability Plot,*

**PERFORMANCE EVALUATION OF SOME ESTIMATORS UNDER UNBALANCED PANEL DATA MODELS**

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**ABSTRACT** This work investigates the efficiencies of five existing methods of estimating panel data models under unbalanced data structure triggered by the presence of missing values. The methods considered are the Between, Random (Swamy-Arora), First Difference, Pooling, and Within estimators. In the Monte-Carlo experiments, unbalanced sample panel data were generated with 5% missingness at random from a published balanced panel data set with five sample units (n) each measured at an equal time interval of five (t). This was done to inject missingness in time (t) or in sample unit (n) or both, thereby creating an unbalanced data structure. The performances of these five estimators were evaluated using the Mean Square Error (MSE) and the Mean Absolute Error (MAE). The results showed that Between estimator, with the least values of MSE and MAE, proved to be the best estimator for Panel data model under an unbalanced data structure. In terms of the order of performances, further results showed that the Within estimator was the second-best followed by the Random estimator with the Pooling estimator at the First Difference having the least performance for estimating unbalanced panel data model, especially under the small sample size situations. This study recommends that the Between estimator should be adopted for fitting the panel data models when evidence of missingness is apparent in the data, especially when the number of sample units is very sma

*Keywords: Panel data, missingness, unbalanced panel data, mean square error, mean absolute error*

**GAMMA-POWER MAXIMUM LIKELIHOOD PARAMETERS ESTIMATION USING NUMERICAL EXPECTATION-MAXIMIZATION ALGORITHM AND ITS REGRESSION MODEL**

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The optimization of the parameters of the mixture of gamma distribution is a problem in the field of probability and statistics. The maximum likelihood estimation is a popular method but sometimes do not converge to the optimal value. The Expectation-Maximization (EM) algorithm has been used to optimize maximum likelihood estimates of gamma, but most of the convoluted distributions with a mixture of gamma have not explore this algorithm. The gamma regression model is a very important model when modelling non-normal data. There are many convoluted gamma distributions that have been developed, but their generalized linear models are scarce in literature. In this paper, a new extension of the gamma linear model, called the Gamma-Power generalized linear model, using the T-Power framework was developed. Some statistical characterization and properties of the distribution are derived such as the survival, hazard, cumulative hazard, reverse hazard rates, transformation to gamma distribution, mode, and likelihood ratio test. The maximum likelihood estimation method was considered to obtain the unknown model parameters using generalized Newton Approximation Method with EM algorithm. The consistency of the maximum likelihood estimates was discussed via a simulation study. Two real data sets were analysed to demonstrate the flexibility and usefulness of the proposed model. The new model would be very useful as alternative in cases where skewed response variables, which are not well fitted with gamma linear models.

*Keywords: Gamma-Power Model, Maximum Likelihood Estimation, Expectation-Maximization Algorithm, Exponential family, Generalized Linear Model*

**COMPARATIVE ANALYSIS OF QUEUING SYSTEM IN TRANSPORTATION COMPANIES - A CASE STUDY OF KWARA EXPRESS AND SUCCESS EXPRESS**

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This research was aimed to examine and compare the queuing system of two transportation companies, observation method was used to obtain data from a private and public transportation corporation using Multiple Channel Queues System. It is concluded that the queuing system practiced in private transportation corporation is better than that of public transportation corporation.

*Keywords: Queue, customer, service station, waiting time, arrival pattern*

**TOPP LEONE EXPONENTIAL – WEIBUL DISTRIBUTION PROPERTIES AND APPLICATION**

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A new distribution called Topp Leone Exponential – Weibul distribution (TLE-W) is developed to improve on its flexibility to compare to some other related distributions. This TLE-W distribution is developed by extending Weibul distribution with Topp Leone Exponential G family of distribution. The respective density and distribution functions of this new distribution (TLE-W) were derived along side with some mathematical properties such as moments, quantile function, renyi entropy and order statistics. Simulation study conducted, by considering the Maximum Likelihood Estimate (MLE) method shows that the estimated parameters of TLE-W are consistent as the BIAS and RMSE approaches zero. Finally, two real data sets were used to validate the results obtained from MLE method. The results shows that TLE-W distribution provides better fit in the two data sets compare to the competitive distributions used in this study. Perhaps, this new distribution may be useful to model positive real life data sets that may possess the characteristics feature of Weibul distribution.

*Keywords: Topp Leone Exponential – Weibul distribution, Mathematical properties, Simulation study, Application to real life data sets.*

**META-ANALYSIS ON EFFECTIVENESS OF JANSSEN VACCINATION IN PREVENTION OF CORONA VIRUS DISEASE IN SOME COUNTRIES**

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The reported outcome of the Corona Virus disease 2019 (COVID-19), classified by World Health Organization (WHO) as pandemic, was very disruptive. This study was intended to evaluate the effectiveness of Janssen vaccination in the prevention of COVID-19 in three different world regions namely: North America, South America and Africa using a comprehensive meta-analysis version 3 software. Data used for this research was secondary data sourced on 1st November 2021, via google search engine as reported from Fact sheet for Healthcare providers administering vaccine (vaccine providers) on emergency use authorization of the Janssen covid-19 vaccine to prevent coronavirus disease 2019 (COVID-19) conducted in the United States of America (United States), Latin America (Brazil) and Southern Africa (South Africa). Samples were obtained from the laboratory for analysis on 12th February 2021. Our findings from the results using fixed and random effect models show a summery effect of 0.000 indicating that the Janssen vaccination, based on the studies included in the meta-analysis, neither favored mortality nor survival. I-square statistic is zero indicating the total absence of bias. The variant of the Covid-19 as at the time the vaccine was tried may have been overwhelming to be put under control, considering the deadly nature of the pandemic. However, the mere fact that the results do not favour mortality, is a testament to the theory that getting vaccinated could mean milder symptoms in patients.

*Keywords: Meta-analysis, COVID-19, Risk, Janssen*

**A DATA ADAPTIVE SELECTION OF THE BEST BIO-MARKER GENES IN THE PREDICTION OF RIBOFLAVIN (VITAMIN B2) PRODUCTION RATE USING SUFFICIENT DIMENSION REDUCTION METHODS WITH INFORMATION COMPLEXITY**

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This work proposes a new shrinkage-sufficient dimension reduction (SSDR) method that contains complete information on all features in high and ultrahigh-dimensional data. The procedure utilized the Maximum Entropy Covariance (MEC) hybridization and maximal covariance complexity-based shrinkage estimation to produce sparse and accurate solutions. The novel contribution here includes the hybridization of the newly proposed MEC estimator by Oloredo and Yahya (2019) with existing smoothed covariance estimators (SCEs) to, data-adaptively, generate shrunken estimates of the inverse MEC estimator. To our knowledge, utilization of SCEs and Hybridized Smoothed Maximum Entropy Covariance Estimator (HSMEC) in SDR formulation is novel in the literature. Our method works in the existing SDR methods, such as Sliced Inverse Regression, Sliced Average Variance Estimation, and principal hessian directions. We demonstrated the proposed methods' utility, versatility, and effectiveness with a real-life undersized benchmark data set to simultaneously predict the Riboflavin (Vitamin B2) production and select the best subset of predictors of the production rate of vitamin B2. The proposed SDR-HSMEC method provides interpretable predictive models that enable a simple and reliable identification of the best subset of predictive genes for the production rate of Riboflavin (Vitamin B2).

*Keywords: Sufficient Dimension Reduction, Maximum Entropy, Smoothed and Hybridized Covariance Estimators, Maximum Entropy Covariance (MEC) Estimator, Information Complexity (ICOMP)*

**STATISTICAL ANALYSIS OF TRADE-DEVELOPMENT LINKAGE IN THE COVID-19 ERA AND BEYOND**

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COVID-19, a pandemic which emerged in December 2019 in China has become a universal challenge to health conditions. The pandemic has tampered with the situations in the global economy creating what is often termed a New Normal. The detrimental effects of the pandemic have penetrated deeply into the world economy leading to a pronounced slack in economic activities including prolonged macroeconomic challenges. The threats of the pandemic are not only on sustainable Development Goals (SDGs) alone but as well making them almost unattainable. As a result, Nigeria, overpowered by the informal sector, experiences a large decline in trade, welfare and consumption levels and demonstrated by the worsening economic performance over time. Based on recent rankings, Nigeria fell in bottom of 10 countries on an aggregate score of 100 in terms of progress made on all 17 SDGs. Attaining the SDGs which proves almost difficult following the pandemic effect and the possibility of achieving the goals in the post COVID era creates a motivation for this study. The study adopts the system theory which helps showcase the perceived influence of a singular factor on growth and which also consequently impact on the SDGs. Aside from the trend analysis, the methodology shall be based on forecasting models such as Vector Autogressive (VAR) models to provide the link between trade and sustainable development in the COVID-19 era and beyond considering the relevant variables as spread rate, death rate, confirmed cases, exports and imports, poverty rate, health care, life expectancy among others. The study concentrates on the start of the pandemic (February, 2020) to the period beyond. Data shall be collected from the Nigeria relevant data source on COVID-19 such as the National Disease Control, Annual report, etc. The outcome of the study is expected to shed more light on the alternative ways of attaining SDGs amidst COVID-19 pandemic considering trade factor.

*Keywords: COVID-19, SDG, VAR, Pandemic*



**THRESHOLD AUTOREGRESSIVE INTEGRATED MOVING AVERAGE ON NIGERIA STOCK EXCHANGE MARKET CAPITALIZATION.**

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The study explores the Threshold Autoregressive Integrated Moving Average (TARIMA) model on Nigeria Stock Exchange Market Capitalization for a period of thirty-four years. The data collected from Central Bank of Nigeria Statistical Bulletin on monthly stock market equities of NSE to compute the monthly stock exchange market capitalization. The ARIMA model and Threshold Autoregressive modeling were adopted for this study. The modeling cycle was in three stages, the first stage was model identification stage, where the series was not non-stationary at level form based on the result provided by the time plot. It was found out that the series was stationary at the first difference. Based on the selection criteria BIC, reports show that ARIMA (2, 1, 2) was selected to be the best model to fit the data. The second stage was the model estimation, where the parameters conforms to the stationary conditions and finally, the third stage was the Threshold Autoregressive Model estimation. The forecasted period showed a market with an unstable monthly stock market returns. It was recommended that, the regulatory authority should initiate policies and laws that would encourage more companies and the public to access the market to ensure effective and efficient functioning of the capital market.

*Keywords: TARIMA, Stock Market, BIC, ARIMA, TAR*

**BAYESIAN DYNAMIC BORROWING OF EXTERNAL DATA IN PAEDIATRIC EXTRAPOLATION AND MULTI-REGIONAL BRIDGING STUDIES**

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In settings such as paediatric drug development or multi-regional clinical trials & bridging studies, a substantial body of evidence typically already exists regarding the drug efficacy and safety in other populations (e.g. adults or other regions). Bayesian dynamic borrowing methods offer a scientifically rigorous way to formally leverage this existing knowledge to better inform drug development and regulatory decision-making in these settings. In this talk, I will introduce the key concepts of Bayesian dynamic borrowing, focusing on the robust mixture prior method introduced by Schmidli et al (2014). Case studies will be presented to illustrate the application of this approach to real examples in a regulatory setting, and the benefits and challenges will be discussed.

*Keywords: External data, paediatric extrapolation, multi-regional bridging studies, Bayesian dynamic borrowing, robust mixture prior*

**BAYESIAN POPULATION PHARMACOKINETICS MODELLING OF COARTEM® IN YOUNG CHILDREN**<sup>1</sup>Isaac Adeola Adeniyi<sup>1</sup> University of Ilorin*Corresponding Author: isaac.adeniyi@fulokoja.edu.ng*

Artemisinin Combination Therapies (ACTs) have been recommended by the WHO for the first-line treatment of uncomplicated falciparum malaria. Artemether (ARM) and lumefantrine (LUM) (the combination is abbreviated AL) combination therapy is currently the most adopted of the ACTs. Coartem, a brand name for AL, is the first fixed dose ACT to be pre-qualified by the WHO. Characterization of the pharmacokinetics (PK) of the three active components of Coartem – ARM, dihydroartemisinin (DHA) and LUM in adults are well documented in the literature. However, PK studies on young children are quite sparse. This study aimed to describe the population PK of ARM and DHA in young children with uncomplicated malaria using pooled data from two published studies. One of the studies involved 800 children aged less than 12 years with weight ranging from 5 to 35 kg from 5 African countries while the other study involved infants weighing 2-5kg. The children were treated of uncomplicated malaria using weight dependent doses of Coartem. Due to the sparse nature of the data, a Bayesian approach was adopted to fit the population PK model of ARM and DHA using Monolix. The hyperparameters for the priors were obtained from literature. The pharmacokinetics of ARM and DHA were described by a one-compartment model with weight dependent central volumes (V) and clearance rates (CL). Typical values of V and CL for ARM were 157.2 L and 25.4 L/h respectively while the first order absorption rate was fixed at 1 h<sup>-1</sup>. For DHA, the population average V and CL were estimated as 88.6 L and 63.1 L/h respectively with the first order absorption rate fixed at 0.4 h<sup>-1</sup>. These PK results from this study can prove useful for optimizing Coartem dosing strategies in young children.

*Keywords: Malaria, Artemether and Lumefantrine, MCMC, Maximum a posteriori (MAP), antimalarial; nonlinear mixed effects modeling*

**DECISION-MAKING IN THE PHARMACEUTICAL INDUSTRY**<sup>1</sup>Alun Bedding<sup>1</sup> Roche*Corresponding Author: alun.bedding@roche.com*

There are many critical point in clinical development where decisions need to be made. Methods for making these decisions vary, however, they all need to be evaluated to ensure there is a high probability of making the correct decision. This talk will look at those decision points and discuss various methods applied, and then how to understand the operating characteristics. The main methods will be illustrated by examples.

*Keywords: Decision-making, operating characteristics*