COMPARATIVE ANALYSIS OF REGRESSION MODELS AND METHODS OF ESTIMATING UNBIASED PARAMETERS FOR CROP PRODUCTION

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Abstract

This work was to establish a predictive equation for crop production. It also provide empirical information and examination on comparative analysis of regression models and methods of estimating unbiased parameters (i.e. six methods) with focus on crop production. Time series secondary data extracted from a survey data carried out in Nigeria on crop production from the National Bureau of Statistics from January 2010 to December 2021 were employed. The analyses of the data were done using these six methods: Arithmetic Mean, Geometric Mean, Harmonic Mean, Wald, Bartlett, and Durbin's Methods. All computations were done via Microsoft Excel, Gretl (version 18.0) and MINITAB (version 20.0). The general regression model is given by $Y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \varepsilon_i$ (cassava and rice production are the independent variables; "x_1" jand "x_2" while crop production is the dependent variable "y_i"). Then, the actual model, centre of mean models and instrumental variables methods models were estimated. The result of the parameters estimated for all the methods models are significant at 5%. In addition, the models' residuals sum of square (RSS), R-square value (R^2), Akaike Information criteria (AIC) and Bayesian Information Criterion (BIC) of the models were calculated and compared. The results of the comparison identify the Model F as the best model which parameter estimates was obtained by the Bartlett Method. Hence, Bartlett Method of estimators is the best-unbiased parameters estimation method using the model selection criteria considered that is R-square value (R^2), AIC and BIC. This paper recommended that the six methods of estimating unbiased parameters should be used with other crop produce to identify the model with the estimators of the best-unbiased parameters.

Keywords: *Unbiased Parameters, Model Selection Criteria, Centre of Mean Models, Instrumental Variables Methods Models, Regression Model, Crop Production*

1. Introduction

Agriculture plays a cardinal position in Nigeria's economic system contributing the best proportion to the country's gross home manufacturing (GDP). For instance, in 2008, agriculture's contribution to total actual GDP changed into 42.07 percent with the crop, farm animals, forestry and fishery accounting for 37.52, 2.sixty five, 1.37 and 0.53 percent, respectively (NBS, 2007; Central Bank of Nigeria (CBN), 2008). This implies that the crop sub-quarter contributed 89.2 percent of agriculture GDP. Further, agriculture generates employment for over 70 percent of the entire labor force, debts for about 60 percent of the non-oil exports and, perhaps maximum crucial, affords over eighty percent of the food desires of the USA (Adegboye, 2004; Onwuemenyi, 2008; CBN, 2008).

Despite those signs, Nigeria's agricultural performance in recent times remains insufficient and indeed a ways less than its potentials. Food call for exceeds the supply as a result main to large importations of meals, which further erodes the economies Cassava and Rice are some of the main staple vegetation in Nigeria and featured among the five food plants (cassava, maize, wheat, rice, and sugar) whose manufacturing is to be promoted for attainment of food self-sufficiency as discovered by way of the Minister of Agriculture and Water Resources (Sayyadi, 2008). In Nigeria, Cassava and Rice production ranks third after sorghum and millet a number of the cereal crops (Food and Agriculture Organization Statistics (FAOSTAT), 2009). Apart from being a meals crop, Cassava and Rice respectively have equally emerged as an industrial crop on which many agro-primarily based industries rely upon for raw materials (Oluwatayo, *et al.*, 2008). Cassava and Rice contribute approximately 80 percent of chicken feeds and this has remarkable implications for carbohydrate intake in Nigeria (FAO, 2008). Thus, Cassava and Rice can be taken into consideration very important to the financial growth of the nation through its contribution to meals security and poverty alleviation.

Cassava is a very reasonably-priced source of carbohydrate and is the main carbohydrate supply in the weight loss plan of the teeming population of the 1/3 global international locations in which it is basically grown. Banjoko *et al.,* (2008) posited that cassava is a supplementary staple food of extra than two hundred million Africans aside from its makes use of as livestock feed specifically for monogastric.

Cassava roots are wealthy in starch and comprise a massive quantity of calcium, phosphorus, and nutrients. However, they may be bad in protein and other nutrients. In contrast, cassava leaves are a true supply of proteins if supplemented with the amino acid methionine, no matter containing cyanide (Odoemenen and Otanwa, 2011). Apart from cassava being processed and fed on as fufu, garri, etc by using each rural and urban dweller in Nigeria, the products also are used for making starch, cattle feed, ethanol manufacturing, adhesive for pharmaceutical industries and flour for confectioneries industries. Given those, efforts have been intensified towards increasing production in the country to a level of sufficiency. One of such commitment becomes the pronouncement and funding of the Obasanjo management to boom production to a level that serves the nucleus of a good deal of industrial.

Cassava all of sudden received prominence in Nigeria following the announcement of a presidential initiative at the crop improved production level. The initiative changed into aimed at the usage of cassava production because the engine increases in Nigeria. In current times, the government has advocated the usage of the crop to provide a wide range of industrial merchandise such as ethanol, glue, glucose, syrup, and bread. The Nigerian authorities have additionally handed a law, making it obligatory for bakers to use composite flour of 10% cassava and 90% wheat for bread production. The new regulation which got here into impact in January 2005, stipulated that the big flour generators that supply flour to bakeries and confectioneries have to pre-mix cassava flour. This initiative has encouraged more farmers to enter cassava manufacturing in Nigeria. However, in spite of this, Omonona, (2009) and Oyegbami *et al.,* (2010) notes that cassava production remains mainly finished using rural smallholder farmers the use of low-level production strategies. Though authorities at various stages have been attempting in various ways to inspire rural farmers to undertake the contemporary cassava production technologies if you want to growth productivity, there are constraints to adoption in rural farming communities (Eze & Nwibo, 2014; Teklewold *et al.*, 2006 and Fresco, 1993).

Rice is a primary commodity in global trade. Rice has grown to be the second one maximum essential cereal within the international after wheat in phrases of manufacturing, due to a recent decline in maize production (Jones, 1995). It is widely cultivated all through the tropics; and where flood controls are powerful as in South-east Asia, manufacturing is excessive. Much of the foreign rice imported into West Africa is from South-east Asia. West Africa bills for sixty four.2% and 61.9% of general rice manufacturing and intake in Sub-Saharan Africa respectively. The River Niger drainage device is a first-rate rice developing environment within the Region. Nigeria has a main position in rice manufacturing in West Africa. Rice is thought to be grown along the Niger for over 3000 years (Imolehin & Wada, 2000). The fashion for the Region is that the manufacturing and intake of rice are growing quicker than for other food staples. The ability of the business manufacturing of rice in West Africa is tremendous.

Rice is one of the plants being taken into consideration below the FGN's ATA given its growing importance and distinguished role amongst staple food crops in Nigeria. The united states have a history of indigenous rice production and excessive demand (Johnson, Takeshima, & Gyimah-Brempong, 2013).Thus, it is not sudden that rice has emerged as a primary staple meal crop in Nigeria, given its demand in all the six geopolitical zones, 36 States, all of the Local Governments, and across all socio-demographic businesses (Gyimah-Brempong, Johnson & Takeshima, 2016). The growing home demand for rice in Nigeria has been attributed to customer preferences, increasing incomes, growing city populace, among others (Nwanze *et al.*, 2006).

Regression evaluation refers to a method of mathematically finding out which variables can also affect. The importance of regression evaluation lies inside the truth that it offers an effective statistical technique that lets in an enterprise to examine the connection between two or more variables.

The advantages of regression analysis are manifold: The regression technique of forecasting is used for predicting and locating the causal relationship between variables. An essential related,

almost identical, the idea includes the blessings of linear regression, which is the process for modeling the value of one variable at the fee(s) of one. Understanding the importance of regression analysis, the advantages of linear regression, as well as the benefits of regression evaluation and the regression approach of forecasting can assist a small business, and indeed any business, gain a far more information of the variables (or elements) that may affect its achievement in the coming weeks, months and years into the future.
The importance of regression analysis is that its miles all about information: information approach numbers and figures that outline your commercial enterprise. The benefits of regression analysis are that it may allow you to crunch the numbers to help you make better selections for your commercial enterprise currently and into destiny. The regression approach of forecasting means studying the relationships among facts factors, which permit you to: (1) Predict income in the near and lengthy-time period. (2) Understand stock stages. (3) Understand supply and call for. (4) Review and recognize how extraordinary variables impact all of these things.

The advantage of regression evaluation is that this type of statistical calculation gives agencies a manner to look into destiny. The regression technique of forecasting lets in groups to use precise strategies in order that those predictions, along with destiny income, future needs for labour or supplies, or may be destiny demanding situations, will yield meaningful statistics.

Jewell and Queensberry (1986) taken into consideration an iterative regression technique from statistics amassed from stratified samples using a design variable, which is correlated with the structured variable however is not covered as an impartial variable. They showed that the technique gave a general advanced estimate of the mean in phrases of efficiency. In these kinds of research, the linear regression of a variable of interest Y (dependent variable) at the auxiliary X (impartial variable) was taken into consideration for the estimation of populace parameters. This takes a look at consequently seeks to recall a case in which the variable of interest Y has a polynomial (non-linear) courting with the auxiliary variable X, that's the unbiased variable. Statistical techniques for estimating the model parameters were developed under the idea of unbiased observations of Draper and Smith (1981).

The statement to the problem: The international food crisis is growing with alarming speed and pressure, necessitating countries and international groups all around the globe to reply with a strategic and lengthy-term method. It has been determined that the current disaster is prompted by way of an internet of interconnected forces involving agriculture, power, weather change, trade, and new marketplace needs from emerging markets and therefore has grave implications for financial increase and development, international security, and social progress in developing countries (Centre for Strategic and International Studies “CSIS”). Nigeria too is currently experiencing meals disaster. This has been attributed to low productiveness within the agricultural sector necessitating huge food imports. Cassava and Rice being a prime staple in Nigeria is of vital concern to agricultural coverage decisions. Current manufacturing is set eight million tonnes and the average yield is less than 1.5 tonnes consistent with hectare. This is far underneath the

potentials of the Nigerian Cassava and Rice area. Thus, there was a developing gap among the call for maize and its supply bobbing up from low productivity.

The restricted capability of the Nigerian Cassava and Rice economy to fit the home demand raises some of the pertinent questions both in the policy circle and amongst researchers. For instance, what elements give an explanation for why home maize manufacturing lags in the back of the demand for the commodity in Nigeria? To bridge the demand-supply hole, the effort has to be channelled towards increasing its productivity. Theoretically, increasing the productivity of maize production might require either multiplied input use in particular acreage growth, development in useful resource use efficiency and or technological alternate derived from the use of new technologies. Given the constant populace strain and different social and financial constraints in Nigeria, acreage expansion as a supply of accelerated productivity has little application. Hence, the united states of America are left with the choice of enhancing the efficiency of farmers through enhancing on their circumstance or eliminating existing institutional, marketplace and socio-monetary constraints and introduction of progressed technology. In line with the problem stated above, these studies work cognizance on comparative analysis of regression fashions and technique of estimating impartial parameters (the use of six strategies) to decide the pleasant version to improve the manufacturing of Cassava and Rice in Nigeria.

The foremost aim of this study is to investigate the comparative analysis of regression models and approach of estimating unbiased parameters (the use of six strategies) with admire to its utility to Nigeria's crop manufacturing; particularly Cassava and Rice productions. This look at additionally intends to permit the communicator to make simple strategies available to cassava and Rice producers and to improve production, garage and processing. The particular objectives are:

1. Obtain the Estimators (parameters) of the centre of means and instrumental variables methods on the linear regression models.
2. Comparison of the six methods of estimating unbiased parameters using Residuals Sum of square (RSS), R-square value (R^2), Accuracy Measures (AIC and BIC) of the Models.
3. Identify the best method of estimating unbiased parameters and regression model in objective (2). This observation is motivated with the aid of the essential role of crop manufacturing inside the Nigerian economy. Crop manufacturing now not only serves as a vital meal staple to a majority of the residents of Nigeria but also a source of revenue for each farm family and the state at huge. Nigeria has a fantastic capacity for higher economic growth both in the quick and long term than is currently skilled via elevated crop manufacturing. Therefore, the want to efficaciously allocate productive resources for development purposes cannot be overstressed. In that case, every resource should be efficiently and successfully mobilized to lessen the distance among real and capacity countrywide output.

But most importantly is to make sure that the kingdom's concerted effort to improving the agricultural era is remunerated with sufficient profits in food protection and monetary increase considering technologies are developed, disseminated and adopted at a value. Given the

comparative nature of this study, the final results in terms of the consistency or in any other case of the effects will shape a foundation for policy recommendations. Thus, the have a look at will make contributions to the literature on financial performance inside the context of appropriate analytical methodology to appoint. Measurement of performance is justified for a number of reasons: firstly, it's far a trademark of overall performance measure by means of which manufacturing units are evaluated, consequently indicating the potentials there's to improve productiveness and family welfare by improving performance. Therefore, information on manufacturing efficiency will help policymakers to become aware of which farmers want help most, for that reason helping in better targeting and priority putting. Secondly, the size of causes of inefficiency makes it viable to explore the sources of efficiency differentials and elimination of causes of inefficiency. Finally, the identity of sources of inefficiency indicates which component of the farm's bodily and human sources needs to be centered via public investment to improve performance.

Finally, the construction of an integrated version will serve as a critical device to manufacturing economists and agricultural policy analysts as this is expected to ease the hassle of model choice for performance and coverage analysis. This study is similarly justified, as it will help the research and extension agents to recognize particularly the numerous troubles faced through the farmers and how nice to make sure that their manufacturing potentials are realized through facilitating generation technology and diffusion thus decreasing manufacturing inefficiencies.

The study is center on a comparative evaluation of regression models and approach of estimating independent(unbiased) parameters (the usage of six methods:) to determine the nice model to enhance crop manufacturing including Cassava and Rice in Nigeria, a quarterly statistics masking the length of 12 years 2010 – 2021.

However, due to inadequate time, unavailability of facts and lack of related literature's constraint, the researcher focuses his attention on the Gross Domestics Product at modern primary prices for crop production (Cassava and Rice productions) and trade the use of secondary records from the National Bureau of Statistics. Implicit fee deflator desk of the rebased GDP figures comparing (46) activity sectors. These studies work specializes in six methods together with Arithmetic Mean, Geometric Mean, Harmonic Mean, Wald, Bartlett, and Durbin's Method.

2. Literature Review

A lot of human beings have achieved studies on crop manufacturing commonly. This bankruptcy deals with the review of some literature works on cassava production, rice production and evaluation of regression models. Other peoples work on a method of estimating unbiased parameters using one of the six techniques consisting of Arithmetic Mean, Geometric Mean, Harmonic Mean, Wald, Bartlett, and Durbin's Methods was also reviewed.

Nigeria is rated as the largest nation on the African continent, with a big geographical landmass of 923,768 km^2. Nigeria has an anticipated populace of over one hundred seventy million inhabitants

(Adegboye, 2004). The country adjoined throughout the tropics of Guinea Gulf on the western coast of Africa and also the Republic of Benin, Chad, and Cameroon inside the east. Nigeria is endowed with plenty of plants, dynamic topography, and feasible agro-climatological situations. Nigeria is likewise one of the few within the continent blessed with exact arable farmland for agricultural activities. Among the Nigerian industries, service bills for 32% of the GDP, manufacturing 11% and agriculture 30%. Therefore, it's mile apparent that the agricultural zone performs an enormous role in the financial boom and development of the Nigerian financial system. Agriculture deals with the cultivation of land for crop manufacturing and rearing of animals for the usage of man and also for the feed of animals (cattle). Agriculture has several different sub-sectors like forestry, fishery, processing and advertising of the rural merchandise. The agricultural area presents task opportunities and raw substances for lots of agro-allied industries.

Agriculture is understood to be a prolonged age practice in the third world and growing nations. The importance of agricultural development to socio-monetary growth and improvement in lots of third international locations is eager on their transition to financial prosperity. Agriculture contributes over one sector of the GDP in the most growing countries of the international, specifically in Nigeria.

Beinteman and Stadt (2006) asserted that most African countries remain dominated with the aid of small-scale farmers who employed crude gear and the usage of in large part fragmented land to cultivate the crop and rear animals for guy's advantage. Most of those peasant farmers dwell within the rural communities in Africa. These account for the overpowering eighty% of the labour force.

Daramola et al. (2007) asserted that agriculture constituted for 60- 70% of the state's export inside the early 1950s and 1960s. Nigeria turned into regarded as a net exporter of most agricultural products like cocoa, rubber, oil palm, palm kernel, groundnut among many different cash plants with a financial fee. The accrual from the exports serves as a core supply of revenue generation for the authorities. The above noted period was when Nigeria was known as meals secured; this is self-sufficient in meals manufacturing with the excess for export.

The implication of the oil boom was the sluggish decline inside the other non-oil sectors, in particular, the agricultural region that received less attention. Much focus changed into geared toward the oil exploration, extraction and the returns it brought (Ifeanyi *et al.,* 2008). Nevertheless, the trend of agriculture in Nigeria over the last long time has no longer been favourable (FAO, 2006). The growth of agriculture inside the sixties and seventies has been experiencing a downward fashion. However, the increased fee accelerated sharply within the 1980s and 1990s. Between these periods, agriculture contribution to GDP rose from 1.1% to 2.3%.

Given Nigeria's discovery of crude oil in business quantity, agriculture that changed into once the prime mover of Nigeria's economy suffered excellent neglect. The resultant effects consist of: a sharp decline in agricultural manufacturing, increasing reliance on meals import to satisfy the

home demand, and so on. In impact, Nigeria is presently certainly one of the biggest food importers in the international with an annual food import bill of about $10 billion (Obayelu, 2015).

Vedat *et al.,* (2016) in their observe on "Estimators Proposed by using Geometric Mean, Harmonic Mean and Quadratic Mean", opined that arithmetic population suggest of the auxiliary variable is used to attain the proportional estimators. Geometric suggest harmonic mean and quadratic imply are used in addition to arithmetic populace mean wherein used because of the theoretical Framework. Using geometric suggest, harmonic suggest and quadratic imply do now not affect the variance of ratio estimator. However, new strategies are received for the estimation and variance of the based variable whilst this method are used as well as mathematics populace mean. The records used for the have a look at turned into a secondary record which changed into the suggest a wide variety of teaching staff of the departments in Ondokuz Mayıs University is expected with the aid of auxiliary variable which is the range of students inside the departments. In addition, the variances of proportional estimation technique are obtained and interpreted by means of the use of population arithmetic imply, geometric imply, harmonic and quadratic imply. The locating of their studies suggests that the variances of estimators, received with the aid of the use of geometric and harmonic means, are smaller. Regression analysis related to Wald, Bartlett and Durbin methods become not use in this have a look at that's truly the space the researcher tends to fill in this cutting-edge take a look at.

Oyinbo and Rekwot, (2014) in their studies work performed on "Agricultural Production and Economic Growth in Nigeria: Implication for Rural Poverty Alleviation" provided empirical information on the connection among agricultural manufacturing and the growth of Nigerian economic system with attention on poverty reduction. Time series facts have been employed within the research and the analyses of the records have been carried out the use of unit root tests and the bounds (ARDL) testing method to cointegration. The result of the information evaluation indicated that agricultural production becomes extensive in influencing the beneficial trend of financial growth in Nigeria. Despite the boom of the Nigerian economy, poverty remains at the boom and this calls for a shift from monolithic oil-primarily based financial system to a greater plural one with agriculture being the lead area. It turned into endorsed that seasoned negative rules ought to be designed for alleviating rural poverty thru multiplied investments in agricultural development with the aid of the private and non-private quarter. Regression model became no longer used in this take a look at what's definitely the gap the researcher tends to fill in this current study.

The researchers Viplav *et al.,* (2009) in their have a look at on "Difference-Type Estimators for Estimation of Mean inside the Presence of Measurement Error", counselled difference-type estimator for estimation of population imply of the examine variable (y) within the presence of dimension errors the usage of auxiliary statistics. The most fulfilling estimator in the counselled estimator has been recognized alongside its suggest square errors formula. It has been proven that the counselled estimator performs more green than other present estimators. An empirical look at is carried to throw mild on the overall performance of recommended estimators over different

current estimators the usage of the easy random sampling scheme. It became found that advised estimator t3 performs higher than the alternative estimators taken into consideration within the present examine and which displays the usefulness of the cautioned approach in practice. There has a look at didn't think about using the Wald, Durbin and Bartlett techniques of estimation inside the presence of errors phrases of the usual unbiased estimator.

Khalaf, (2013) in his research paintings on "A Comparison between Biased and Unbiased Estimators in Ordinary Least Squares Regression", pointed out that during the past years, exceptional sorts of estimators have been proposed as alternatives to the Ordinary Least Squares (OLS) estimator for the estimation of the regression coefficients within the presence of multicollinearity. In the general linear regression model, $Y = X\beta + e$ it's far regarded that multicollinearity makes statistical inference hard and might even seriously distort the inference. Ridge regression, as considered here, defines a category of estimators of β indexed with the aid of a scalar parameter ok. Two strategies of specifying k are proposed and evaluated in terms of Mean Square Error (MSE) via simulation techniques. A comparison is made with different ridge-type estimators evaluated elsewhere. It became observed out that the predicted MSE of the suggested estimators is lower than other estimators of the ridge parameter and the OLS estimator. The different elements selected to differ are the pattern size and the range of regressions. They generate fashions which include 25, 50, 100 and 150 observations and with 2 and 4 explanatory variables. It is cited from the outcomes of the simulation research that increasing the quantity of regressor and using non-regular pseudo-random numbers to generate i .e. leads to a higher estimated MSE, even as increasing the pattern size ends in a decrease anticipated MSE.

Dankyi, and Adjekum, (2007) in their look at on "Determinants of the adoption of advanced cassava types in Southern Ghana - logistic regression evaluation" conducted a benchmark adoption survey underneath the Root and Tuber Improvement Project of Ghana in 2001 to offer baseline indicators of adoption and effect for cassava. The pattern length of the survey become 150 farmers decided on at random from 18 agricultural districts under 5 of the regions of southern Ghana. The adoption price for improved cassava varieties changed into nine%. The adoption intensity that is the vicinity below advanced cassava cultivation changed into 37% inside the 2001 crop season. The imply length of fields planted to stepped forward cassava by farmers turned into 3.6 hectares compared with 0.8 hectares through farmers planting local varieties. This method that farmers who plant progressed cassava types may additionally appear few but domesticate large discipline sizes than their counterparts who plant local varieties. For farmers who never used progressed cassava varieties, their motives were associated with the availability of advanced cassava planting material. Most of them did no longer recognise approximately the improved types or could not get them to plant. In a logistic regression evaluation to determine the elements affecting the adoption of the stepped forward varieties, land tenure, overall subject size farmed in 2001 and decisions with extension body of workers on cassava with farmers had a fantastic and full-size impact at the adoption of improved cassava types. Years of self-selection on farming and whether or not farmers had ever bought cassava cuttings were, however, negatively related and considerable. This shows

that farmers who've lately been in cassava cultivation are much more likely to adopt progressed cassava types than their counterparts with longer experience. Gender and planting arrangement did now not have a giant effect despite the fact that they were positively associated. They failed to make use of the Wald, Durbin and Bartlett techniques of estimation in the presence of mistakes terms of the usual unbiased estimator.

Ashish *et al.,* (2018) in there have a look at on "Improved estimators for populace mean in presence of size error" proposed a few progressed class of estimators of populace suggest in presence of size error the use of auxiliary variable based totally on mathematics imply, geometric mean and harmonic implications of the standard unbiased estimator. The expressions of bias and MSEs had been received up to the first order of approximation. The performances of the proposed estimators have checked the use of actual population facts set. In addition, an empirical examine changed into accomplished in the support of theoretical effects. Their take a look at did not make used of the Wald, Durbin and Bartlett strategies of estimation within the presence of blunders phrases of the standard impartial estimator.

Kingsley *et al.,* (2018) in their study, examined the "Comparative Cost and return Analysis of Cassava Production by way of Adopters and Non-adopters of advanced Cassava Varieties among Farmers in Ibesikpo Asutan LGA, Akwa Ibom country, Nigeria". A multistage sampling approach was used to choose a hundred respondents in a ratio of fifty adopters and 50 no- adopters. Data were accumulated through a questionnaire and analyzed the use of descriptive and inferential statistics. Gross margin changed into carried out to estimate the value and go back. Results revealed that females (68 % and sixty-four %) were dominant for both businesses of cassava farmers. The majority (88 %) of the farmers had been educated, implying that they would be greater amenable to adopt technologies. The value and return evaluation indicates that the overall variable price per hectare become N56455.00 and N36850.00 with a gross margin of N77550.00 and N36560.00 for adopters and non- adopters respectively, indicating that, cassava farming is profitable. Determinants of cassava production for each group of farmers were farm size, cassava cuttings, fertilizer use and extension contact. Whereas improved farm length, cassava cuttings and extension contact considerably and positively inspired output of each corporation of farmers, fertilizer use had a negative but massive effect on the output of adopters, implying that fertilizer use resulted in a decreased output of the adopters. The adapters are advice to discontinue the use of fertilizer. Furthermore, lack of expertise and a high fee of inputs had been most of the fundamental constraints to complete adoption of improved cassava sorts within the study vicinity. Therefore, it's far recommended that regulations aimed at enhancing farmer's education and recognition need to be redesign for proper implementation. Their observation didn't think about the use of the Arithmetic suggest, Geometric imply, Harmonic suggest, Wald, Durbin and Bartlett techniques of estimation inside the presence of errors phrases of the same old unbiased estimator.

Osabuohien *et al.,* (2018) in their observe on "Rice Production and Processing in Ogun State, Nigeria: Qualitative Insights from Farmers' Association", investigated the significance of indigenous institutional preparations in rice manufacturing and processing sports in Ogun State,

Nigeria via using Key Informant Interviews (KIIs). Analyses from the examination confirmed that agricultural financing constitutes the finest project that influences rice manufacturing and processing. Other findings from the discourse revealed that in some rice-producing regions wherein there's the existence of rice farmers' clusters; there's get right of entry to modern rice processing machines which includes winnowers, threshers and designers. The operations of Rice Growers Association of Nigerian-RGAN in Ogun State are coordinated by way of the government committee, which represents the indigenous institutional association. This has a look at recommends that honest and concerted efforts on the part of the government in enforcing the desires of Agricultural Transformation Agenda be made to engender the welfare of rice farmers via the development of the rice value chain. The need for activities related to the rice farmers thru the RGAN is also germane. The opportunities identified in the have a look at include: the having 'pool of land' RGAN that enables the rice farmers to shape clusters and boom production; growing platform via which the rice growers may want to leverage upon to facilitate get entry to inputs and technical help; gaining of visibility and market get admission to beautify returns on their farming endeavours. Although, the issue of using the Arithmetic imply, Geometric mean, Harmonic mean, Wald, Durbin and Bartlett methods of estimation inside the presence of error phrases of the standard independent estimator were not tested within the examine.

3. Materials and Methods

This studies painting are focused at regression analysis inside the presence of error term in variables and techniques of estimating independent and constant regression parameters within the presence of mistakes time period in variables the usage of the methodology of Arithmetic Mean, Geometric Mean, Harmonic Mean, Wald, Bartlett, and Durbin's Methods.

The accumulated and used facts for this study is a secondary statistics extracted from survey information performed in Nigeria on crop production (especially on Cassava manufacturing and Rice production) from the National Bureau of Statistics from January 2010 to December 2021. Implicit price deflator table of the rebased GDP figures evaluating 46 interest sectors of the Nigeria economy data was used. The data are presented in Appendix A. Two impartial regression fashions have been proposed one that expressed crop manufacturing in the time period of Cassava Production and the other in term of Rice production.

The following programmes are used to acquire the parameters which constitute the models; a number of which include Gretl (version 18.0) and MINITAB (version 20.0). To facilitate records evaluation, the researcher made use of Microsoft Excel 2013, Gretl (version 18.0) and MINITAB (version 20.0). Microsoft Excel 2013 and MINITAB (version 20.0) had been utilized in estimating the parameters for Actual Mean, Arithmetic Mean, Geometric Mean, Harmonic Mean, Wald, Durbin and Bartlett's Methods.

3.1 Model Specification

Suppose we have a regression model of the shape

$$Y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \varepsilon_i \quad (3.1)$$

We outline the size errors and as follows:

$$\delta_i = \bar{X}_1 - X_1 \text{ and } \delta_j = \bar{X}_2 - X_{21} \quad (3.2)$$

where,

$\bar{X}_1$ = The anticipated values for Cassava manufacturing and

$\bar{X}_2$ = The estimated values for Rice production.

Since we've two explanatory variables; it's miles assured that X_1 and X_2 are the original values of the explanatory variables.

$$\text{Thus, } X_1 = \bar{X}_1 - \delta_i, \; X_2 = \bar{X}_2 - \delta_j \quad (3.3)$$

Then substituting equation (3.3) into equation (3.1) we've got;

$$Y_i = \beta_0 + \beta_1(\bar{X}_1 - \delta_i) + \beta_2(\bar{X}_2 - \delta_2) + \varepsilon_i \quad (3.4)$$

$$Y_i = \beta_0 + \beta_1 \bar{X}_1 - \beta_1\delta_i + \beta_2 \bar{X}_2 - \beta_2\delta_j + \varepsilon_i$$

We can similarly rewrite the equation above as follows:

$$Y_i = \beta_0 + \beta_1 \bar{X}_1 + \beta_2 \bar{X}_2 + (\varepsilon_i - \beta_1\delta_i - \beta_2\delta_j) \quad (3.5)$$

The version said above may additionally appear like an everyday regression model with predictor variables $\bar{X}_{i1}$ and $\bar{X}_{i2}$ with errors $(\varepsilon_i - \beta_1\delta_i - \beta_2\delta_j)$ however, this isn't always. The explanatory variables observations and are random variables which are correlated with the error term $(\varepsilon_i - \beta_1\delta_i - \beta_2\delta_j)$. For the motive of this research work, we can use additional variables which are acknowledged to be associated with the explanatory variables however not to the mistakes of size. Such variables are referred to as instrumental variables. The use of instrumental variables makes it possible to reap steady estimators of the regression parameters. This method will be utilized in this study.

Table 3.1 Model Specification

Variable	Model	Description	Mathematical Formulation
Central of Means	A	Actual value	$Y_i = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \varepsilon_i$
	B	Arithmetic Mean	$y_i = \beta_0 + \beta_1 z_1 + \beta_2 z_2 + \varepsilon_i$
	C	Geometric Mean	$y_i = \beta_0 + \beta_1 g_1 + \beta_2 g_2 + \varepsilon_i$
	D	Harmonic Mean	$y_i = \beta_0 + \beta_1 h_1 + \beta_2 h_2 + \varepsilon_i$
Instrumental variables Methods	E	Wald	$y_i = \beta_0 + \beta_1 a_1 + \beta_2 a_2 + \varepsilon_i$
	F	Bartlett	$y_i = \beta_0 + \beta_1 b_1 + \beta_2 b_2 + \varepsilon_i$
	G	Durbin	$y_i = \beta_0 + \beta_1 d_1 + \beta_2 d_2 + \varepsilon_i$

Table 3.1 above shows a summary of the fashions (crucial of method, and instrumental variables techniques) that are used in the look at to achieve the important independent parameter estimates within the presence of blunders terms inside the variables.

where $z_1 = (x_1 - \bar{x}_{m1})$ and $z_2 = (x_2 - \bar{x}_{m2})$

where $g_1 = (x_1 - \bar{x}_{Gm1})$ and $g_2 = (x_2 - \bar{x}_{Gm2})$

where $h_1 = (x_1 - \bar{x}_{Hm1})$ and $h_2 = (x_2 - \bar{x}_{Hm2})$

where $d_1 = Rank$ of x_1 and $d_2 = Rank$ of x_2

3.2 Instrumental variables Methods of Estimating Regression Coefficient in the Presence of Error in Two Variables

Six techniques might be contemplating in this section. These techniques are Arithmetic Mean, Geometric Mean, Harmonic Mean, Wald, Bartlett, and Durbin's Methods.

3.2.1 Arithmetic Mean Method

The arithmetic mean, or briefly, the implications of a hard and fast of N numbers $X_1, X_2, \ldots, X_n$ is denoted by (read "X bar") and is defined as

$$\bar{X} = \frac{X_1 + X_2 + X_3 + \ldots + X_N}{N} = \frac{\sum_{i=1}^{N} X_i}{N} = \frac{\sum X}{N} \tag{3.6}$$

where N is the overall variety of cases.

3.2.2 Geometric Mean (G) Method

The geometric imply G of a set of N tremendous numbers $X_1, X_2, X_3..., X_N$ is the N^{th} root of the product of the numbers denoted with the aid of G capital and described as

$$G = \sqrt[N]{X_1 X_2 X_3}...X_N \tag{3.7}$$

3.2.3 Harmonic Mean (H) Method

The harmonic mean suggests H of a set of N numbers X_1, X_2, X_3…, X_N is the reciprocal of the mathematics imply of the reciprocals of the numbers. It is denoted by way of H, and described as;

$$H = \frac{1}{\frac{1}{N}\sum_{i=1}^{N}\frac{1}{X_i}} = \frac{N}{\sum\frac{1}{X}} \tag{3.8}$$

In practice, it is able to be simpler to don't forget that

$$\frac{1}{H} = \frac{\sum\frac{1}{X}}{N} = \frac{1}{N}\sum\frac{1}{X} \tag{3.9}$$

3.2.4 Wald Method

The following steps are concerned in Wald Method:

Step 1: Find the median of given observations*; $X_{11}, X_{21},..., X_{n1}$ and $X_{12}, X_{22},..., X_{n2}$*.

Step **2:** After that, then we classify the observations by using defining an instrumental variable W such that

$$W_{ij} = \begin{cases} 1, \text{if } X_{ij} > \text{median } (X_{ij}\text{'s}) \\ -1, \text{if } X_{ij} < \text{median } (X_{ij}\text{'s}) \end{cases} \tag{3.10}$$

In this case, the instrumental variable W is a matrix of the form;

$$W = \begin{bmatrix} 1 & W_{11} & W_{12} \\ 1 & W_{21} & W_{22} \\ \vdots & \vdots & \vdots \\ 1 & W_{n1} & W_{n2} \end{bmatrix} \tag{3.11}$$

In which, X is the matrix of explanatory variables and is of the form:

$$X = \begin{bmatrix} 1 & X_{11} & X_{12} \\ 1 & X_{21} & X_{22} \\ \vdots & \vdots & \vdots \\ 1 & X_{n1} & X_{n2} \end{bmatrix} \tag{3.12}$$

and Y is of the shape:

$$Y = \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix}$$

and $\hat{\beta}_{IV} = (W^{\mathrm{I}} X)^{-1} W^{\mathrm{I}} y$ (3.13)

$$W^{\mathrm{I}} y = \begin{bmatrix} 1 & 1 & \cdots & 1 \\ W_{11} & W_{21} & \cdots & W_{n1} \\ W_{12} & W_{22} & \cdots & W_{n2} \end{bmatrix} \begin{bmatrix} y_1 \\ y_2 \\ \vdots \\ y_n \end{bmatrix} = \begin{bmatrix} \sum_{i=1}^{n} y_i \\ \sum_{i=1}^{n} W_{i1} y_i \\ \sum_{i=1}^{n} W_{i2} y_i \\ \sum_{i=1}^{n} W_{i3} y_i \end{bmatrix}$$

$$W^{\mathrm{I}} X = \begin{bmatrix} 1 & 1 & \cdots & 1 \\ W_{11} & W_{21} & \cdots & W_{n1} \\ W_{12} & W_{22} & \cdots & W_{n2} \end{bmatrix} \begin{bmatrix} 1 & X_{11} & X_{12} \\ 1 & X_{21} & X_{22} \\ \vdots & \vdots & \vdots \\ 1 & X_{n1} & X_{n2} \end{bmatrix}$$

$$W^{\mathrm{I}} X = \begin{bmatrix} n & \sum_{i=1}^{n} X_{i1} & \sum_{i=1}^{n} X_{i2} \\ \sum_{i=1}^{n} W_{i1} & \sum_{i=1}^{n} W_{i1} X_{i1} & \sum_{i=1}^{n} W_{i1} X_{i2} \\ \sum_{i=1}^{n} W_{i2} & \sum_{i=1}^{n} W_{i2} X_{i1} & \sum_{i=1}^{n} W_{i2} X_{i2} \end{bmatrix} \tag{3.14}$$

$$V(\hat{\beta}_{IV}) = MSE(W^{\mathrm{I}} X)^{-1} (W^{\mathrm{I}} W)(W^{\mathrm{I}} X)^{-1} \tag{3.15}$$

If n is odd, then the middle commentary can be deleted. Using this approach, the estimators are constant but are in all likelihood to have a big variance that is the issue of the Wald's Method.

3.2.5 Bartlett's Method

Let $X_{11}, X_{21},\ldots,X_{n1}, X_{12}, X_{22},\ldots, X_{n2}$ be the n observations. To use this method, we follow the subsequent process:

Step1: Rank these observations and organize them in an increasing or lowering order.

Step2: Three agencies may be formed, each containing observations. Define the instrumental variables as

$$W_t = \begin{cases} 1, \text{if observation is in the top group} \\ 0, \text{if observation is in the middle group} \\ -1, \text{if observation is in the bottom group} \end{cases} \quad (3.16)$$

where,

Wt is as described in equation (3.17), x and y as described earlier in the preceding page in equation (3.13) and (3.14) respectively.

$$V(\hat{\beta}_{IV}) = MSE(W^{I}X)^{-1}(W^{I}W)(W^{I}X)^{-1} \quad (3.17)$$

3.2.6 Durbin's Method

Let $X_{11}, X_{21},\ldots,X_{n1}, X_{12}, X_{22},\ldots, X_{n2}$ be the n observations. The following methods have to be followed whilst the use of Durbin's technique:

Step1: Arrange these observations in ascending order.

Step2: Define the instrumental variable W_{ij} because of the rank of (X_{ij})

Step3: Substituting the precise values of W and X in and

3.3 Model Selection Criteria

To find the correct manufacturing characteristic we use model choice criterion. The model that minimizes the criterion is the fine model. In current years, several criteria for choosing some of the models have proposed this whole version which takes the form of residual sum of squares mistakes (SSE) multiplied via a penalty thing that depends upon the complexity of the fashions. The two accuracy measures considered are discussed beneath:

3.3.1 Akaike Information Criteria (AIC)

Akaike (1983) developed a manner that's called Akaike Information criteria. The form of this information is given under:

$$AIC = n\ln\left[\frac{SSE}{n}\right] + 2(k) \tag{3.18}$$

where; N = Sample size, K = Number of parameter and SSE = Sum of square error.

3.3.2 SCHWARZ Bayesian Information Criterion (BIC)

Another information criterion method is referred to as SCHWARZ (BIC) criteria. The form of this method is given below as:

$$BIC = n\ln\left[\frac{SSE}{n}\right] + k\ln(n) \tag{3.19}$$

The fee of SCHWARZ (BIC) will also decrease provided there are as a minimum of eight observations (Kutner *et al.,* 2005).

3.3.3 Coefficient of Determination (R^2)

R^2 is one of the essential statistical parameters used in decision making and for statistical inferences. It is a manner used to determine the share of results of 1 or extra variables over the others. The form of this process is represented as:

$$R^2 = \frac{SSR}{SST} \tag{3.20}$$

where; SSR= Sum of square Residual

SST= Sum of Square Total

3.4 Summary of Material and Methods

Solving the device of equations supplied above will deliver us the parameter estimates. There are a few programmes that could resolve these structures of the equation; some of which include R-bundle and MINITAB model 20.0. There are various optimization functions in R that may be used in imposing this. These optimization features are “nlm”, “optim”, “maxlik”, and “nlminb”. Ones the poor log-likelihood characteristic is provided, the R will do the optimization. There are exclusive algorithms to be had in R. This algorithm uses the cost of the function in addition to the gradients within the optimization. To facilitate records evaluation, the researcher made use of Microsoft Excel 2017, MINITAB version 20. zero and R bundle. Microsoft Excel 2017 and

MINITAB 20. zero were utilized in estimating the parameters for Arithmetic Mean, Geometric Mean, Harmonic Mean, Wald, Durbin and Bartlett's Methods at the same time as the MLE turned into envisioned in R package deal the use of algorithm. The R-codes and MINITAB code are furnished inside Appendix B, C, D, E, F, G, H, I, J, and K respectively. The variance-covariance for the estimator for Wald, Durbin and Bartlett's Methods is given in Equation 3.17:

$$Var(\hat{\beta}) = MSE(W^{I}X)^{-1}(W^{I}W)(W^{I}X)^{-1}$$

4. Results

This section offers with the results for a description of the variable; relevant imply of the impartial variables, Arithmetic suggests, Geometric mean, Harmonic mean, Wald approach, Bartlett method, Durbin approach and discussion of findings.

4.2 Descriptive Statistics and Preliminary of the Variables

In this section, the plots and the descriptive statistics of the dependent variable and independent variables have been also achieved (Table 4.1). In addition, the simple linear regression of the dependent variable and the independent variable was done.

Table 4.1: Descriptive Statistics précis of the Variables

Variables	Crop Production (Y)	Cassava Production (X_1)	Rice Production (X_2)
Mean	4032.128	1488.392	150.178
Variance	1299366.300	169337.289	4435.898
Standard Deviation	1139.897	411.506	66.603
Geometric Mean	3875.508	1436.779	133.942
Harmonic Mean	3722.807	1350.357	116.648
Median	3971.065	1440.195	149.590

Results in table 4.1 above, précis the variables imply, variance, well-known deviation, geometric imply, harmonic imply and median on the crop, cassava and rice productions respectively.

4.2.1 Regression Plots of Actual Values (Crop and Cassava Productions)

From Minitab 20 results output, the outfitted line plot has a linear trend model given through;

$\hat{y}$ = 640.3 + 2.279*Cassava;

in which $\hat{y}$ is the number of annual recorded GDP of crop manufacturing and t is the quantity of annual recorded GDP of cassava production. This shows that cassava productions defined 67.7% of crop production.

Figure 4.1 suggests the regular opportunity plot of response (crop manufacturing) indicating the behaviour of their per cent and Residual for the GDP of Cassava and Crop Production.

Figure 4.2 indicates the summary of residual versus equipped fee plot of reaction (crop production) for the GDP of Cassava and Crop Production.

Regression Plots of Actual Values (Crop and Rice Productions)

Similarly, Minitab 20 results output, the outfitted line plot has a linear trend version given via;

$\hat{y}$ = 2045 + 13.23*rice,

where $\hat{y}$ is the variety of annual recorded GDP of crop manufacturing and t is the wide variety of annual recorded GDP of rice production. This additionally suggests that rice productions defined 59 .8% of crop production.

Figure 4.3 indicates the regular probability plot of reaction (crop production) indicating the behaviour of their per cent and Residual for the GDP of rice and crop production.

Figure 4.4 shows the précis of residual as opposed to fitted cost plot of response (crop production) for the GDP of cassava and rice manufacturing.

4.3 Multiple Regression Model Parameters Estimates

4.3.1 Result for Centre Mean of the Independent Variables

Table 4.2: Statistics of the Independent Variables (Model A)

Model A	Parameter ± SE	t-test	P-value	Remark
β_0	847 ± 399.10	2.12	0.042	Significant
β_1	1.55 ± 0.395	3.91	0.000	Significant
β_2	5.89 ± 2.44	2.41	0.021	Significant

Footnote: Significant at p< zero.05

The regression model is

$$\hat{y} = 847 + 1.55x_1 + 5.89x_2 \quad (4.1)$$

The table 4.2 summarised parameter estimates, probability value (p-value), t-test and standard errors of the actual values for the GDP of the crop, cassava, and rice productions respectively. The effects of parameters are significance at 5%.

4.3.2 Result for Arithmetic Centre Mean

Table 4.3: Statistics of the Arithmetic Centre Mean (Model B)

Model B	Parameter ± SE	t-test	P	Remark
β_0	4032.10 ± 102.50	39.32	0.000	Significant

β_1	1.55 ± 0.395	3.91	0.000	Significant
β_2	5.894 ± 2.441	2.41	0.021	Significant

Footnote: Significant at p< zero.05

The regression model is

$$\hat{y} = 4032 + 1.55\, z_1 + 5.89\, z_2 \quad (4.2)$$

The table 4.3 summarised parameter estimates, t-test, p-value and standard error of the arithmetic centre mean for the GDP of the crop production with respect to cassava and rice productions, showed similar result outcomes of the parameters which are significant at 5%.

4.3.3 Result for Geometric Mean

Table 4.4: Statistics of the Geometric Mean (Model C)

Model C	Parameter $\pm$ SE	t-test	P	Remark
β_0	3856.7 ± 106.1	36.35	0.000	Significant
β_1	1.55 ± 0.395	3.91	0.000	Significant
β_2	5.894 ± 2.441	2.41	0.021	Significant

Footnote: Significant at p< 0.05

The regression model is

$$\hat{y} = 3857 + 1.55\, G_1 + 5.89\, G_2 \quad (4.3)$$

Likewise in the table 4.4, the geometric centre mean parameter estimates for the GDP of the crop production with respect to cassava and rice productions are also significant at 5%.

4.3.4 Result for Harmonic Mean

Table 4.5: Statistics of the Harmonic Mean (Model D)

Model D	Parameter $\pm$ SE	t-test	P	Remark
β_0	3621.2 ± 115.4	31.37	0.000	Significant
β_1	1.55 ± 0.395	3.91	0.000	Significant
β_2	5.894 ± 2.441	2.41	0.021	Significant

Footnote: Significant at p< 0.05

The regression version is

$$\hat{y} = 3621 + 1.55\, h_1 + 5.89\, h_2 \quad (4.4)$$

Table 4.5, showed the harmonic centre mean parameter estimates for the GDP of the crop production with respect to cassava and rice productions are also significant at 5%.

4.3.5 Result for Wald Method

$$w'x = \begin{bmatrix} 36 & 53582.11 & 5406.39 \\ 0 & 11842.95 & 1684.71 \\ 0 & 10882.57 & 1992.95 \end{bmatrix}$$

$$(w'x)^{-1} = \begin{bmatrix} 0.0278 & -0.2528 & 0.1384 \\ 0 & 0.0004 & -0.0003 \\ 0 & -0.0021 & 0.0023 \end{bmatrix}$$

$$\hat{\beta}_{IV} = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \end{bmatrix} = \begin{bmatrix} 387.626 \\ 1.976 \\ 4.689 \end{bmatrix} \quad w'x = \begin{bmatrix} 145156.6 \\ 31295.45 \\ 30843.63 \end{bmatrix}$$

$$V(\hat{\beta}_{IV}) = \begin{bmatrix} 0.0278 & 0.253 & 0.1378 \\ 0 & 7.27*10^{-6} & -7.4*10^{-6} \\ 0 & -7.25*10^{-5} & 7.7*10^{-5} \end{bmatrix}$$

Table 4.6: Statistics of the Wald Method (Model E)

Model E	Parameter $\pm$ SE	t-test	P	Remark
β_0	387.86 ± 0.0278	13954.42	0.0001	Significant
β_1	$1.976 \pm 7.27*10^{-6}$	271581.3	0.000	Significant
β_2	$4.689 \pm 7.7*10^{-5}$	60898.47	0.001	Significant

Footnote: Significant at $p < 0.05$

The regression Model is

$$\hat{y} = 387.626 + 1.975A_1 + 4.689A_2 \quad (4.5)$$

Table 4.6, showed the Wald technique parameter estimates for the GDP of the crop production with respect to cassava and rice productions are significant at 5%.

4.3.6 Result for Bartlett Method

$$w'x = \begin{bmatrix} 36 & 53582.11 & 5406.39 \\ 0 & -10649.2 & 1602.09 \\ 0 & -9476.69 & 1771.22 \end{bmatrix}$$

$$(w'x)^{-1} = \begin{bmatrix} 0.0278 & 0.3297 & -0.2134 \\ 0 & -0.0005 & 0.0004 \\ 0 & 0.0026 & -0.0029 \end{bmatrix}$$

$$\hat{\beta}_{IV} = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \end{bmatrix} = \begin{bmatrix} 606.605 \\ 1.677 \\ 6.194 \end{bmatrix} \quad w'x = \begin{bmatrix} 145156.6 \\ -27776.8 \\ -26858.5 \end{bmatrix}$$

$$V(\hat{\beta}_{IV}) = \begin{bmatrix} 0.0278 & 0.331 & 0.215 \\ 0 & 4.94*10^{-6} & -5.201*10^{-6} \\ 0 & -5.6*10^{-5} & 6.237*10^{-5} \end{bmatrix}$$

Table 4.7: Statistics of the Bartlett Method (Model F)

Model F	Parameter $\pm$ SE	t-test	P	Remark
β_0	606.605 ± 0.0278	21837.59	0.0001	Significant
β_1	$1.677 \pm 4.94*10^{-6}$	339384.59	0.0001	Significant
β_2	$6.194 \pm 6.237*10^{-5}$	99256.99	0.0001	Significant

Footnote: Significant at $p < 0.05$

The regression Model is

$$\hat{y} = 606.6045 + 1.677b_1 + 6.194b_2 \quad (4.6)$$

Furthermore, table 4.7 showed the Bartlett technique parameter estimates for the GDP of the crop production with respect to cassava and rice productions are significant at 5%.

4.3.7 Result for Durbin Method

$$w'x = \begin{bmatrix} 36 & 53582.11 & 5406.39 \\ 666 & 1137224 & 120261.6 \\ 666 & 1114162 & 124344.5 \end{bmatrix}$$

$$(w'x)^{-1} = \begin{bmatrix} 0.194 & 0.3297 & 0.00774 \\ -7.1*10^{-5} & 2.29*10^{-5} & -1.9*10^{-5} \\ -0.0004 & 0.00012 & 0.00014 \end{bmatrix}$$

$$\hat{\beta}_{IV} = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \beta_2 \end{bmatrix} = \begin{bmatrix} 590.234 \\ 1.844 \\ 4.644 \end{bmatrix} \quad w'x = \begin{bmatrix} 145156.6 \\ 3048535 \\ 3024971 \end{bmatrix}$$

$$V(\hat{\beta}_{IV}) = \begin{bmatrix} 0.198 & 0.0163 & 0.0071 \\ -2.9*10^{-6} & 2.37*10^{-7} & -7.884*10^{-8} \\ -5.9*10^{-5} & -1.7*10^{-5} & 1.97*10^{-5} \end{bmatrix}$$

Table 4.8: Statistics of the Durbin Method (Model G)

Model G	Parameter ± SE	t-test	P	Remark
β_0	590.23 ± 0.198	2975.73	0.0001	Significant
β_1	$1.84 \pm 2.37*10^{-7}$	7780289.84	0.0001	Significant
β_2	$4.64 \pm 1.97*10^{-5}$	235717.57	0.0001	Significant

Footnote: Significant at $p < 0.05$

The regression Model is

$$\hat{y} = 590.2338 + 1.844d_1 + 4.644d_2 \quad (4.7)$$

Finally, table 4.8 showed the Durbin technique parameter estimates for the GDP of the crop production with respect to cassava and rice productions are also significant at 5%.

Table 4.9: Regression Analysis Summary of the Parameter Estimates

MODELS	PARAMETER ESTIMATES β_0	β_1	β_2	MSE	$R^2(adj)$	R^2	AIC	BIC
Model A	847 ± 399.10 (0.042) 2.12	1.55 0.395 (0.000) 3.91	5.89 2.44 (0.021) 2.41	378551	70.9%	72.5%	468.39	473.138
Model B	4032.10 ± 102.50 (0.000) 39.32	1.55 ± 0.395 (0.000) 3.91	5.894 ± 2.441 (0.021) 2.41	378551	70.9%	72.5%	468.39	473.138
Model C	3856.7 ± 106.1 (0.000) 36.35	1.55 ± 0.395 (0.000) 3.91	5.894 ± 2.441 (0.021) 2.41	378551	70.9%	72.5%	468.39	473.138
Model D	3621.2 ± 115.4 (0.000) 31.37	1.55 ± 0.395 (0.000) 3.91	5.894 ± 2.441 (0.021) 2.41	378551	70.9%	72.5%	468.39	473.138
Model E	387.86 ± 0.0278 (0.001) 13954.42	1.976 ± 7.27*10^{-6} (0.000) 271581.3	4.689 ± 7.7*10^{-5} (0.001) 60898.47	362428.73	69.6%	71.3%	466.82	471.572
Model F	606.61 ± 0.0278 (0.001) 21837.59	1.677 ± 4.94*10^{-6} (0.001) 339384.59	6.194 ± 6.24*10^{-5} (0.001) 99256.99	351853.45	**97.9%**	**97.9%**	**465.76**	**470.51**
Model G	590.23 ± 0.198 (0.001) 2975.73	1.84 ± 2.37*10^{-7} (0.001) 7780289.84	4.640 ± 1.97*10^{-5} (0.001) 235717.57	353123.17	70.4%	72.05%	465.88	470.63

Table 4.9 show a summarised regression analysis of parameter estimates, AIC, BIC, MSE, $R^2(adj)$, R^2, standard error, t-test and p-values for the models (A to G). Note that all the models' parameters estimates are significant at 5%, which appear unbiased. The "excellent" model among

several models in Table 4.9 is Model F (Bartlett Method), which has the highest R-square value with 97.9%, have the smallest AIC and BIC values of 465.76 and 470.51. Hence, Bartlett Method of estimating is adequate. However, all the estimators' methods performance properly and have been also extensive and adequate.

4.3 Discussion of Findings

Firstly, the fitted line plot accomplished among the crop manufacturing in opposition to cassava manufacturing and crop manufacturing against rice manufacturing shows a linear model, where cassava productions defined 67.7% of crop manufacturing and rice productions defined 59.8% of crop manufacturing. However, the studies have taken into consideration six methods of parameter estimators and the real regression model parameter. The models are Actual Model, the centre of Arithmetic mean, the centre of Geometric mean, the centre of Harmonic imply, Wald method, Bartlett Method and Durbin method. Next, comparative analysis of regression model and approach of estimating independent parameters (using six methods) was carried out. The Estimators of the methods applied to the regression model are centre of mean and instrumental variables methods. Then, these parameters had been in comparison at 5% level of significant. The result of the parameters confirmed that the actual model, centre of mean models and instrumental variables are all significant at 5%. Furthermore, the models' residuals sum of square (RSS), (R^2), AIC and BIC of the models had been calculated and in comparison. The result of the comparison identified Model F as the best model (Bartlett Method). Hence, Bartlett Method of estimators is the best unbiased parameters estimation method using the model selection criteria considered that is R-square value (R^2), AIC and BIC.

5. Conclusion

Cassava and Rice are the principal carbohydrates in Nigeria that are consumed via a huge range of people in the country. Thus, this study acquires an unbiased parameter estimate in the direction of accuracy and developed efficiency regression models with the least AIC, BIC, and R-square value (R^2) which can be used to improve the production of crops to boom the financial system of the country.

The Estimators of the methods apply on the regression model are centre of mean and instrumental variables methods which have been carefully inserted into the Minitab software (version 18.0) and Microsoft Excel program for data analysis. The parameter Estimators techniques coefficients obtain for the centre of mean and instrumental variables techniques are all significant at 5%. Finally, the regression models and method of estimating independent parameters have been identified by way of evaluating AIC, BIC, and R-square value (R^2).

In light of the study's findings, the subsequent suggestions are proposed:

1. The Model F has been the suitable regression model which parameter estimates are significant (Bartlett Method) should be used to forecast the GDP of crop production with respect to cassava and rice productions in Nigeria.
2. The study also recommended that the six methods of estimating unbiased parameters should be used with other crop produce to identify the model with the estimators of the best-unbiased parameters.

References

1. Adegboye, R.O. (2004). *Land, agricultural and food security in Nigeria, 3rd faculty lecture, faculty of agriculture,* University of IIorin.

2. Akaike (1983). *Information Measured Middle Selection Bull*. Internet Safety Institution 50, 227-290.

3. Ashish, S., Nitesh, K. A., Rajesh, S., & Narendra, K. (2018). Improved estimators for populace mean in the presence of measurement errors. *International Journal of Statistics and Applied Mathematics* 3(1): 201-210

4.Banjoko, A.C., Smith, L., and Lapointe, S.L. (2008). Recent advances in Cassava pest management. *Annu. Rev. Entomol*. (44) 343-70.

5. Beinteman, N.M., and Stadt, G.J. (2006), Agricultural research and development in sub-sahara africa: an era of stagnation. Washington, DC: *International Food Policy Research Institute*.

6. Central Bank of Nigeria, CBN (2008). Central Bank of Nigeria Annual report—December 2017 Retrieved March 29, 2020, from https://www. cbn.gov.ng/out/2017/fprd/fsr%20december%20 2017%20(2).pdf.

7.Central Bank of Nigeria, CBN (2017). Central Bank of Nigeria Annual report—December 2017 Retrieved March 29, 2020, from https://www. cbn.gov.ng/out/2017/fprd/fsr%20december%20 2017%20(2).pdf

8. Dankyi, A.A., & Adjekum, A.A. (2007). Determinant of the adoption of improved cassava types in Southern Ghana - logistic regression evaluation. *Crops Research Institute, ISTRC Symposiu*m, 13, 641 - 647

9. Daramola, A., Ehui, S., Ukeje, E., McIntire, J. (2007). Agricultural export potential in Nigeria. Available on 20/12/2019 from http://www.Csae.Ox.Ac.Uk/ books/epopn/AgriculturalexportpotentialinNigeria.Pdf Draper, N.R., & Smith, H. (1981). *Applied regression analysis*. John Wiley, New York.

10. Eze, A.V., & Nwibo, S.U. (2014). Economic and technical efficiency of cassava manufacturing in Ika North East Local Government Area of Delta State, Nigeria. *Journal of Development and Agricultural Economics*. 6(10): 429-436. DOI:10.5897/JDAE2013.0541

11. FAO (2006). Prospect for food, nutrition, agriculture and major commodity groups, being an interim report on world agriculture towards 2030-2050 Rome:
12, FAO Food & Agriculture Organization (2008). FAO international information and early warning gadget on food and agriculture, global meals programme (GIEWS). *Special record on markets, prices and food scenario for Benin, Niger and Nigeria*.

13. Fresco, L.O. (1993). The dynamics of Cassava in Africa, an outline of studies issues. *COSCA running paper*. (9)

14. Gyimah-Brempong, K., Johnson, M. & Takeshima, H. (2016). *The Nigerian rice economy: policy options for transforming production, marketing, and trade*. Pennsylvania: University of Pennsylvania Press.

15.Ifeanyi, N.N., Felix, C., Remy, O.M., Jude, C.N., Nnanna, M.A.M., & Joe, O. (2008). Empirical assessment of Nigeria's agricultural export and economic welfare, *MPRA* 12, 636

16.Imolehin, E.D., & Wada, A.C. (2000). Meeting the rice production and consumption demands of Nigeria with improved technology. *International Rice Commission Newsletter*. Retrieved online on 15/12/2019 from Http://www.Fao.Org/docrep/x7164t/7164t04.Html

17. Jewell, N.P., & Queensberry, C.P.Jr., (1986). Regression analysis based totally on stratified samples. *Biometrika*, 73, 605-661

18. Johnson, M., Takeshima, H., & Gyimah-Brempong, K. (2013). Assessing the potential and policy alternatives for achieving rice competitiveness and growth in Nigeria. *The International Food Policy 1Research Institute (IFPRI). IFPRI Discussion* Paper, 01301

19.Jones, M.P. (1995). The rice plant and its environment. WARDA Training Guide 2. WARDA, *Bouaké*, 27-30.
20. Khalaf, G. (2013). "A comparison among biased and unbiased estimators in ordinary least squares regression," *Journal of Modern Applied Statistical Methods*: 12(2), 17. DOI: 10.22237/jmasm/1383279360

21Kingsley, O.I., Eucharia, A.A., & Mediong, J. U. (2018). Comparative cost and go back analysis of cassava production by means of adopters and non-adopters of advanced cassava varieties among farmers in Ibesikpo Asutan LGA, Akwa Ibom State, Nigeria.

22. *Global Journal of Agricultural Sciences*, 17: 33-41. DOI: Retrieved online on 15/12/2019 from https://dx.Doi.Org/10.4314/gjass.V17i1.4 Newspaper.

23.Kutner M. H, Neter, J. Nachtsheim, C.J, & Wasserman, W. (2005). Applied linear statistical models. *International Journal of Production*

.
24. NGA-NACSPILOT-LIVESTOCK POULTRY-2007-v1.0. (2007). Country, Nigeria. Producer(s), *National Bureau of Statistics (NBS) - Federal...*

25. Nwanze, K.F., Mohapatra, S., Kormawa, P., Keya, S., & Bruce-Oliver, S. (2006). Rice development in sub-saharan Africa. *Journal of the Science of Food and Agriculture*, 86 (5), 675–677.

26.Obayelu, E.A. (2015). The transformation from subsistence to commercial agriculture in Nigeria: The effects of large-scale land acquisition on smallholder farmers. In E. Osabuohien (Ed.), *Handbook of Research on In-Country Determinants and Implications of Foreign Land Acquisitions (*409-431). Hershey, PA: Business Science Reference.

27.Odoemenem, I.O., & Otanwa, L.B. (2011). Economic analysis of cassava production in Benue State, Nigeria. *Current Research Journal of Social Science*. 3(5): 406-411.

28. Okafor, F.C. (2002). *Sample survey theory with applications*. Afro-Orbis Publishers, Nsukka, Nigeria

29.Oluwatayo, A.B., Sekumade, A., & Adesoji, S.A. (2008). Resource use efficiency of maize farmers in rural Nigeria: evidence from Ekiti State, Nigeria. *World Journal of Agricultural Science*. 4(1), 91 – 99.

30.Omonona, B. T. (2009). The efficiency of resource-use in cassava production in Kogi State, Nigeria: implications for food protection and environmental degradation. Retrieved on 30 August 2015 from http://www.Cababstractsplus.Org/absracts/searc results

31.Onwuemenyi, O. (2008): Taking agriculture to industrial fame in Nigeria. – Punch

32.Osabuohien, E., Okorie, & Otoo, J. A., (1994). Rapid Multiplication of Cassava, *IITA Training Guide. P. 51. IITA*, Ibadan, Nigeria

33. Oyegbami, T., Oboh, G., & Omueti, O., 2010. Cassava processors recognition of the profession and environmental hazards associated with cassava processing in South-Western Nigeria. *African Journal of Food, Agriculture and Nutrition Development*. 10(1), 1982-2000.

34.Oyinbo, O., & Rekwot G.Z. (2014). Agricultural production and economic growth in Nigeria: implication for rural poverty alleviation; *Quarterly Journal of International Agriculture.* 53(3), 207-223

35. Sayyadi, A.R. (2008). *Nigeria targets to be self-enough in the manufacturing of primary food resources.* Trade Invest Nigeria, Tue, 11 Mar 2008. Retrieved online on 15/12/2019 from Http://www.Tradeinvestnigeria.Com/news/231171.Html

36.Shalabh, F. (1997): Ratio technique of estimation inside the presence of dimension errors. *Journal of Indian Society of Agricultural Statistics* 50(2): 150– 155.

37. Teklewold, H., Dadi, L., Yami, A., & Dana, N., (2006). Determinants of adoption of fowl generation: A double-hurdle approach. *Livestock Research and Rural Development*. 18(3): 356-388.

38.Vedat, S., Tolga, Z., Erdinç, Y., & Murat, S., (2016). Estimators proposed by way of geometric mean, harmonic mean and quadratic mean. *Science Journal of Applied Mathematics and Statistics.* 4(3), 115-118, DOI: 10.11648/j.Sjams.20160403.15

39.Viplav, K., Singh, R.S., & Florentin, S. (2009). Difference-type estimators for estimation of mean within the presence of measurement error. *Journal of the Indian Statistical Association*. 28, 31-39.

APPENDIX A

Table C.1.11: Gross Domestic Product at Current Basic Prices for Crop Production and Trade (N' Billion) /1

Year/Quarters		Activity Sector		
		Cassava	Rice	Crop Production
2010	Q1	930.02	46.35	2262.18
	Q2	954.30	94.02	2561.46
	Q3	1220.55	160.35	3660.10
	Q4	1045.39	103.03	3200.16
+2011	Q1	982.55	48.97	2389.95
	Q2	972.45	95.81	2610.18
	Q3	1308.91	171.96	3925.05
	Q4	1162.83	114.61	3559.68
2012	Q1	1105.21	55.08	2688.31
	Q2	1080.94	106.50	2901.39
	Q3	1420.39	186.60	4259.36
	Q4	1379.25	135.94	4222.17
2013	Q1	1157.39	57.68	2815.22
	Q2	1135.96	111.92	3049.06
	Q3	1510.20	198.40	4528.68
	Q4	1460.00	143.90	4469.36
2014	Q1	1212.97	60.45	2950.44
	Q2	1200.85	118.31	3223.24
	Q3	1642.75	215.81	4926.15
	Q4	1539.50	151.73	4712.75
2015	Q1	1291.45	64.37	3141.32
	Q2	1308.17	128.89	3511.30
	Q3	1795.14	235.83	5383.13
	Q4	1683.72	165.95	5154.22
2016	Q1	1473.43	73.44	3583.98
	Q2	1496.61	147.45	4017.08
	Q3	1934.50	254.14	5801.03
	Q4	1790.46	176.47	5480.99
2017	Q1	1870.45	184.37	4054.82
	Q2	1769.53	301.34	5070.87
	Q3	1921.36	260.55	3181.91
	Q4	1799.57	198.09	5997.66
2018	Q1	1987.88	200.47	6188.35
	Q2	2221.05	213.98	4435.03
	Q3	2116.30	224.55	5340.85
	Q4	2700.08	199.08	5899.16
2019	Q1	2132.84	226.22	5481.02
	Q2	2167.67	230.33	5559.34
	Q3	2202.51	234.44	5637.66
	Q4	2237.34	238.55	5715.98

2020	Q1	2272.18	242.66	5794.30
	Q2	2307.01	246.77	5872.61
	Q3	2341.85	250.88	5950.93
	Q4	2376.68	254.99	6029.25
2021	Q1	2411.52	259.10	6107.57
	Q2	2446.35	263.21	6185.89
	Q3	2481.19	267.32	6264.21
	Q4	2516.02	271.43	6342.53

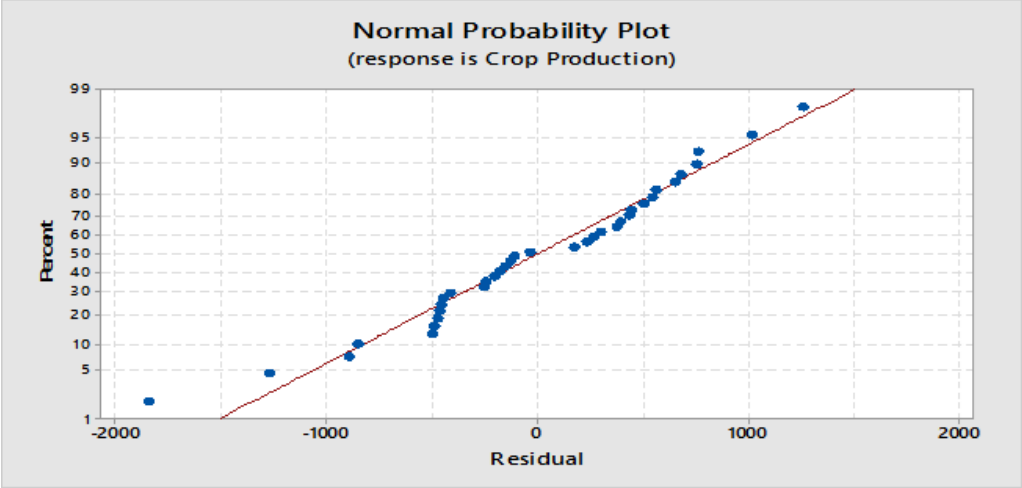

Figure 4.1: Normal chance plot for crop and cassava prods.

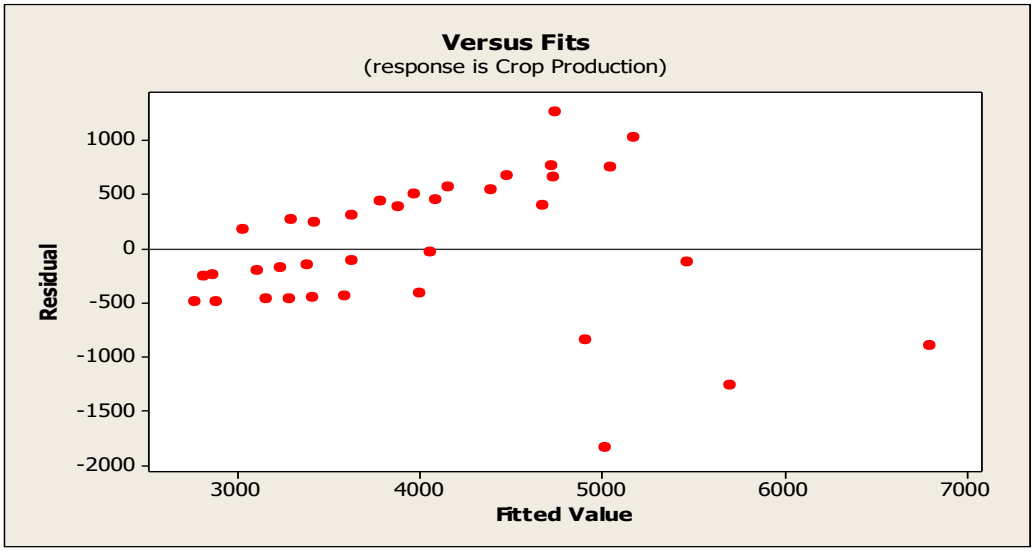

Figure 4.2: Residual Versus Fitted price Plot for cassava and crop prod.

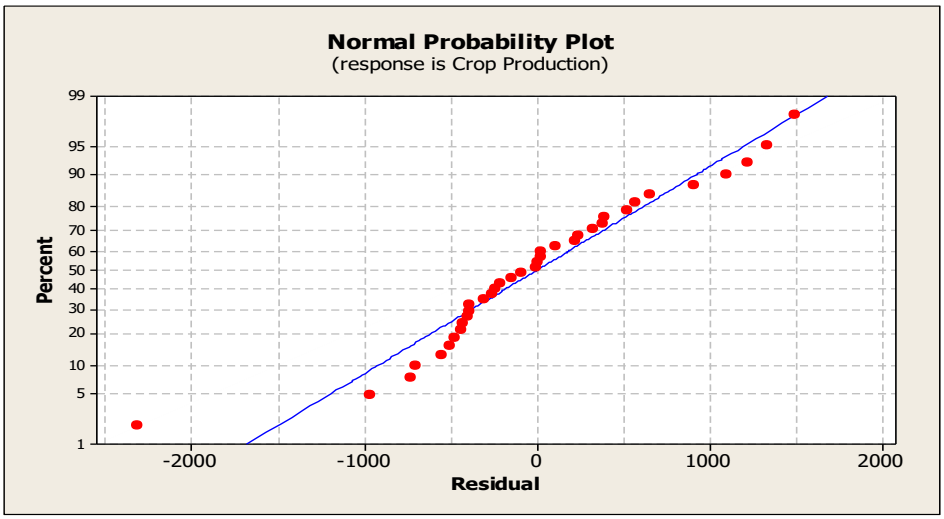

Figure 4.3: Normal opportunity plot for crop and rice Prod

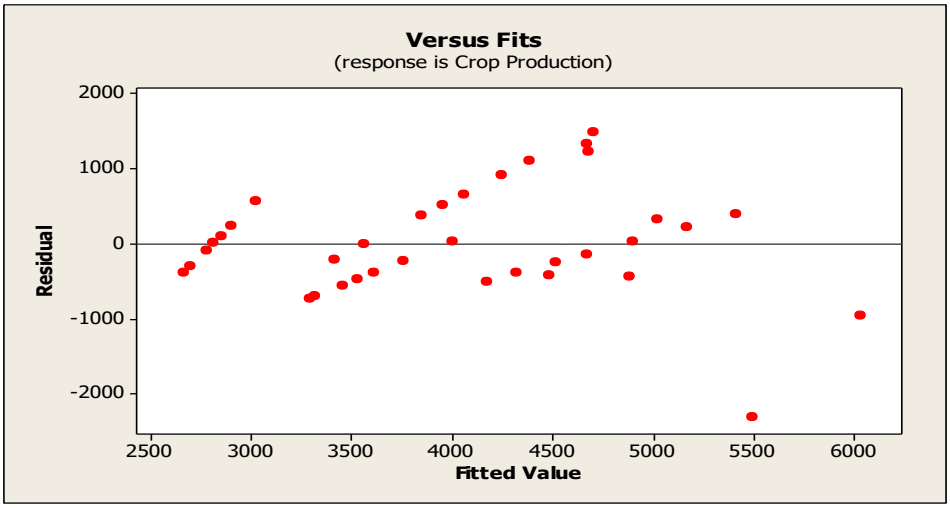

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Figure 4.4: Residual Versus Fitted price Plot for rice and crop prod.