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A Comparative Study for Detection and Remedy Methods of Heterocedasticity Problem in Linear Model Using Actual and Simulated Data

دراسة مقارنة لطرق إكتشاف ومعالجة مشكلة عدم تجانس التباين في النموذج الخطي بإستخدام البيانات الحقيقية وبيانات المحاكاة

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بسم الله الرحمن الرحيم

الآيـــــة

﴿ إِقْرَأْ بِاسْمِ رَبِّكَ الَّذِي خَلَقَ (1) خَلَقَ الْإِنْسَانَ مِنْ عَلَقٍ (2) اقْرَأْ وَرَبُّكَ الْأَكْرَمُ (3) الَّذِي عَلَّمَ بِالْقَلَمِ (4) عَلَّمَ الْإِنْسَانَ مَا لَمْ يَعْلَمْ (5)[1]

صَدَقَ ٱللَّهُ ٱلعَظِيمِ

[1] سورة العلق – الآيات (1 - 5)

Dedication

This thesis is dedicated to:

The sake of Allah, my Creator and my Master,

My great teacher and messenger, Mohammed (May Allah bless and grant him), who taught us the purpose of life,

My great parents, who never stop giving of themselves in countless ways,

My dearest wife: Wafaa, who leads me through the valley of darkness with light of hope and support,

My beloved kids: Farha, and Ghassan, whom I can't force myself to stop loving

My beloved brothers and sisters,

To the soul of role model Dr. Ahmed Hamdi we ask Allah for him to has a mercy and forgiveness

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Abstract

Constructing an econometric model to be suitable for forecasting necessarily requires that it should be free from measurement problems (Heterocedasticity, Auto-correlation and Multicollinearity). The main object of this research focused on the problem of Heterocedasticity by comparing common detection methods (Breuch-Pagan Godfry, Harvey, Glejser, ARCH LM, White, Park, Spearman's Rank Correlation Coefficient and Gold-Field Quandt) and apply all five Remedies in addition to sixth remedy (suggested by the researcher) on the actual data (government expenditures as a dependent variable with GDP, inflation, money supply and exchange rate as independent variables in the period from 1977 to 2018) and other simulated data was corresponding to the actual data in order to testing hypotheses which most important of it are: There are no Significant differences among the results of all common detection methods and remedies when applied to the actual data once and re-applied to the simulation data again, and by analyzing them using statistical packages (SPSS V.20), (E.Views V.9) and (Excel V.10) program. And the most important result in actual data was that the best test led to the detection of Heterocedasticity is White's Test based on the criteria of the coefficient of determination (R^2) and the probability value (Prob-Value), which proved its advantage in helping to detect the problem when applied in the original model and the remedies and the best remedy that led to remove the problem was the fifth remedy using the logarithm. It was proven that 7 out of the 8 detection methods led to the remedy, followed by the sixth remedy (suggested by the researcher) based on the general condition, where it is proven 5 out of the 8 methods of detection led to the remedy of the problem. In other side the most important results after applied in simulated data was that the best test led to the detection of Heterocedasticity is also White's Test, based on the determination coefficient (R^2) and the probability value (Prob-Value) too, which proved its advantage in helping to detect the problem when applied in the simulated model and the remedies. The best remedy that led to remove of the problem here was the first remedy because it was proven that 6 out of the 8 detection methods led to the remedy, followed by the third and fifth (by using logarithm) Assumptions. It was proven that 5 out of the 8 detection methods led to the remedy, According to all research results for actual data and simulated data, the research recommend using White's Test to detect the problem of Heterocedasticity and remedy by taking logarithms.

المستلخص

إنّ بناء نموذج إقتصادي قياسي يصلح للتنبؤ يقتضي بالضرورة بمكان خلوه من مشاكل القياس (عدم تجانس التباين ، الارتباط الذاتي و التداخل الخطي المتعدد) حيث هدف البحث بشكل خاص الى دراسة مشكلة عدم تجانس التباين بمقارنة كل طرق الاكتشاف الشائعة وهي (بريش باقان (Breuch-Pagan Godfry) ، هارفي (Harvey) ، غليجسر (Glejser)، آرش (ARCH LM)، وايت (White) ، بارك (Park) ، سبيرمان للرتب (Spearman's Rank Correlation Coefficient) وقولد فيلد كواندت (Gold-Field Quandt) وتطبيق كل المعالجات الشائعة بالإفتراضات الخمسة وسادسة (مقترحة من الباحث) على البيانات الحقيقية وهي (المصروفات الحكومية متغيراً تابعاً و الناتج المحلي الإجمالي ، التضخم ، عرض النقود وسعر الصرف متغيرات مستقلة في الفترة من العام 1977 وحتى العام 2018) وبيانات المحاكاة وذلك لإختبار فرضيات أهمها: ليست هنالك فروقات معنوية بين نتائج كل الإختبارات الشائعة ومعالجاتها عند تطبيقها على البيانات الحقيقية مرة وإعادة تطبيقها على بيانات المحاكاة مرة أخرى وبتحليلها باستخدام الحزم الإحصائية (SPSS V.20) ، برنامج (E.Views V.9) و (Excel V.10) تم التوصل الى نتائج أهمها أنه عند التطبيق على البيانات الحقيقية فأنّ أفضل إختبار أدى الى إكتشاف المشكلة هو إختبار وايت (White's Test) بناءً على معياريّ معامل التحديد (R^2) والقيمة الاحتمالية (Prob-Value) لأنه أثبت أفضليته في المساعدة على إكتشاف المشكلة عند تطبيقه في النموذج الأصلي والمعالجات ، أما أفضل معالجة أدت الى إختفاء المشكلة كانت المعالجة الخامسة بإستخدام اللوغاريثم حيث أنّه وبتطبيقها ثبت أنّ 6 طرق إكتشاف من بين 7 أدت للمعالجة ، تلتها المعالجة السادسة (مقترحة من الباحث) إستناداً على الحالة العامة حيث أنها وبعد التطبيق أثبتت أنّ 5 طرق إكتشاف من بين 7 أدت لمعالجة المشكلة. في الجانب الآخر فإنّ أبرز النتائج التي تم التوصل لها عند التطبيق في بيانات المحاكاة هي أنّ أفضل اختبار أدى إلى الكشف عن مشكلة عدم تجانس التباين هو أيضًا إختبار وايت (White's Test) كذلك بناءً على معياريّ معامل التحديد (R^2) والقيمة الاحتمالية (Prob-Value) ، أما أفضل معالجات أدت الى معالجة المشكلة كانت المعالجتين الثالثة والخامسة حيث أنهما وبعد التطبيق ثبت أنّ 5 طرق إكتشاف من بين 7 أدت لمعالجة المشكلة، عليه ووفقًا لجميع نتائج البحث المُتحصل عليها من التطبيق على البيانات الحقيقية مرة وإعادة تطبيقها على بيانات المحاكاة مرة أخرى وبعد مقارنة نتائجهما أوصى البحث باستخدام اختبار White's Test للكشف عن مشكلة عدم التجانس ومعالجتها بإستخدام المعالجة الخامسة (بأخذ اللوغريثمات).

List of Contents

الآيـــــة i

Dedication:...... ii

Acknowledgement iii

Abstract...... iv

المستلخص v

List of Contents vi

List of Tables ix

List of Figures...... xi

Chapter One ......

1.2. Problem of Research: 1

1.3. Importance of Research: -...... 2

1.4. Objective of Research:...... 2

1.5. Data of Research:...... 2

1.6. Research Hypotheses:...... 2

1.7. Methodology of Research:...... 3

1.8. Previous Studies:...... 3

1.9. Research Structure: 7

Chapter Two: Conceptual Framework......

2.1. Linear Regression Model...... 8

2.2. Multiple Linear Regression Model (MLR):...... 8

2.3. Coefficient of determination...... 9

2.4. Problems of Regression Model: 9

2.5. Heterocedasticity 9

2.6. Detection of Heterocedasticity: 10

2.7. Remedies of Heterocedasticity:...... 17

2.8 Simulation Concept: 21

2.8.1 Definition of Simulation: 22

2.8.2 Advantages of Simulation: 22

2.8.3 Disadvantages of Simulation:...... 22

2.8.4 Simulation Steps: 23

2.8.5 Some software packages used in modeling simulation: **25**
Chapter Three ....
3.1. Concept of National Income: **26**
3.2. National Income Definition: **26**
3.3. Importance of National Income: **27**
3.4. Government Expenditures: **28**
3.5. The most important variables affecting on the Government Expenditures: **29**
Chapter Four: Application and Discussion ....
Firstly: For Original Model: **34**
4.1. Description of study variables: 34
4.2. Sufficiency Test for actual data: 34
4.3. Description of the study variables for actual data: 35
4.4. Descriptive Statistics of the study variables of actual data: 38
4.5. Estimation of MLR of the original model and its significance test: 39
4.6. Detection of Heterocedasticity for the actual Model: 41
4.7. Comparison between Detection Methods for Heterocedasticity of the Actual Model 47
4.8. Remedies of Heterocedasticity for the Actual Model: 48
4.9. Comparison of Detections Methods of Heterocedasticity for the Actual Model: 57
4.10. Comparison of Remedies of Heterocedasticity for the Actual Model: 58
4.11. Sufficiency Test for Simulated Data: 58
4.12. Estimation of MLR of the simulated model and its significance test: 59
Firstly: estimate MLR model for simulated model: **59**
4.13. Detection of Heterocedasticity for the Simulated Model: 60
4.14. Comparison between Detection Methods of Heterocedasticity for the Simulated Model: 66
4.15. Remedies of Heterocedasticity for the Simulated Model: 67
4.16. Comparison of Detections Methods of Heterocedasticity for the simulated model: 76
4.17. Comparison of Remedies of Heterocedasticity for the simulated model: 77
4.18. Comparison of Remedies of Heterocedasticity for the both model: 77
Chapter Five: Results and Recommendations ....
5.1. Results: 78

5.2. Recommendations:.. 80
References and Appendix.. 78
References.. 81
Appendix (1): Actual Data ....
Appendix (2) Simulated Data...

List of Tables

Table (5 - 1) Test value (K M O) for actual Model 35

Table (5 - 2): Descriptive Statistics of the study variables of actual data 38

Table (5 - 3): Estimate MLR of the Original model 39

Table (5 - 4): table of Analysis of variance for the Original estimated model (ANOVA) 41

Table (5 - 5): Breusch - Pagan - Godfrey test results for actual model 41

Table (5 - 6): Harvey test results for actual model 42

Table (5 - 7): Glejser Test Results for actual model 42

Table (5 - 8): ARCH LM test results for actual model 43

Table (5 - 9): White test results for actual model 43

Table (5 - 10): Park test results for actual model 44

Table (5 - 11): results of the ranks correlation coefficient test for actual model 44

Table (5 - 12): Estimates of the First Group of the Gold-Field Quandt Test for actual model 45

Table (5 - 13): Estimates of the Second group of the Gold-Field Quandt Test for actual model 46

Table (5 - 14): Comparison between Detection Methods of Heterocedasticity for the Actual Model 47

Table (5 - 15) the relative importance of the variables for the actual model 48

Table (5 - 16): ANOVA Table for the first remedy of actual model 48

Table (5 - 17): Comparison between Detection Methods of Heterocedasticity for First Remedy of the Actual Model 49

Table (5 - 18): ANOVA Table for the second remedy of the Actual Model 50

Table (5 - 19): Comparison between Detection Methods of Heterocedasticity for Second Remedy of the Actual Model 50

Table (5 - 20): ANOVA Table for the third remedy of the Actual Model 51

Table (5 - 21): Comparison between Detection Methods of Heterocedasticity for the third Remedy 52

Table (5 - 22): ANOVA Table for the fourth remedy of the Actual Model 53

Table (5 - 23): Comparison between Detection Methods of Heterocedasticity for the fourth Remedy of the actual model 53

Table (5 - 24): ANOVA Table for the fifth remedy of the Actual Model 54

Table (5 - 25): Comparison between Detection of Heterocedasticity for the Fifth Remedy of the Actual Model 55
Table (5 - 26): ANOVA Table for the sixth remedy of the Actual Model........ 56
Table (5 - 27): Comparison between Detection of Heterocedasticity for the Sixth Remedy of the Actual Model 56
Table (5 - 28) Comparison of Detections Methods of Heterocedasticity for the Actual Model 57
Table (5 - 29) Comparisons of Remedies of Heterocedasticity for the original Model........ 58
Table (5 - 30) Test value (K M O)........ 58
Table (5 - 31): estimate MLR for simulated model: 59
Table (5 - 32): table of Analysis of variance for the estimated simulated model (ANOVA) 60
Table (5 - 33): Breusch - Pagan - Godfrey test results for the Simulated Model........ 61
Table (5 - 34): Harvey test results for the simulated Model 61
Table (5 - 35): Glejser Test results for the simulated Model 61
Table (5 - 36): ARCH LM test results of the simulated Model........ 62
Table (5 - 37): White test results of the simulated Model 62
Table (5 - 38): Park test results........ 63
Table (5 - 39) results of the ranks correlation coefficient test........ 63
Table (5 - 40): Estimates of the First Group of the Gold-Field Quandt Test........ 64
Table (5 - 41): Estimates of the Second group of the Gold-Field Quandt Test........ 65
Table (5 - 42): Comparison between Detection Methods of Heterocedasticity for Simulated Model........ 66
Table (5 - 43) the relative importance of the variables........ 67
Table (5 - 44): ANOVA Table for the first remedy........ 67
Table (5 - 45): Comparison between Detection Methods of Heterocedasticity for First Remedy of the simulated Model 68
Table (5 - 46): ANOVA Table for the second remedy of the simulated Model:........ 69
Table (5 - 47): Comparison between Detection Methods of Heterocedasticity for Second Remedy of the simulated Model 69
Table (5 - 48): ANOVA Table for the third remedy of the simulated Model........ 70
Table (5 - 49): Comparison between Detection Methods of Heterocedasticity for the third Remedy of the simulated Model:........ 71
Table (5 - 50): ANOVA Table for the fourth remedy of the simulated model........ 72

Table (5 - 51): Comparison between Detection Methods of Heterocedasticity for the fourth Remedy for the simulated model 72

Table (5 - 52): ANOVA Table for the fifth remedy for the simulated model 73

Table (5 - 53): Comparison between Detection Methods of Heterocedasticity for the fifth Remedy of the simulated model 74

Table (5 - 54): ANOVA Table for the sixth remedy of the simulated model 75

Table (5 - 55): Comparison between Detection Methods of Heterocedasticity for the sixfith Remedy of the simulated model 75

Table (5 - 56) Comparisons of Detections Methods of Heterocedasticity for the simulated model: 76

Table (5 - 57) Comparisons of Remedies of Heterocedasticity for the simulated model: 77

Table (5 - 58): Comparison of Remedies of Heterocedasticity for the both model 77

<u>List of Figures</u>

Figure (5 - 1): Description of the Expenditure Variable (EXPE) 35

Figure (5 - 2): Description of the Gross domestic product Variable (GDP) 36

Figure (5 - 3): Description of the inflation variable (INF) 36

Figure (5 - 4): Description of the Money Supply variable (MS) 37

Figure (5 - 5): Description of the Exchange rate variable (EXCH_Of) 38

Chapter One

Introduction

1.1 Introduction:

Multiple linear regression is one of the branches of econometrics and it is concerned with studying and analyzing the effect of several independent quantitative variables on a quantitative dependent variable. The adopted (one variable) by assessing this relationship, but this model has problems that we will discuss in detail later, and these problems have remediess that had to be examined, choosing the best of them, applying their methods, and using the simulation method to confirm or deny the preference through the results that the study will obtain and compare results. This study is applied to the Government Expenditures as one of important variable impact on the national income, which is considered one of the important and widespread economic concepts in the world of economics. There is hardly any economic conference or meeting of specialists in the economy in the country or even students specialized in this field from using the term national income. The study of national income and understanding what this term means will help to understand many economic matters that are intertwined and intertwined with each other, especially when it is related to statistics and the construction of predictive models for it according to scientific methodology and statistical foundations. It should be noted here that we will use the multiple linear regression method by taking the Government Expenditures as a dependent variable and the variables gross domestic product (GDP), Inflation (INF), Money Supply (MS) and Exchange Rate (EXCH) are will be the independent variables.

1.2. Problem of Research:

Building a multiple linear regression model and estimating its parameters without knowing or without checking the conditions and assumptions that must be met when applying it leads to incorrect results and predictions, and it is necessary here to indicate that the variables and data of any statistical study using the multiple linear regression method often or most of them suffer from correlation problems Auto-correlation between random errors, Heterocedasticity and Multicollinearity, which requires the researcher to test the model and then remedy it if it is found that it suffers from the above problems, and this requires building a problem-free model suitable for prediction. We must point out here that each of the problems of the model has one or several remedies. The research here focused in particular on the problem of Heterocedasticity, and the existing questions here are:

- What is the best test that helps to detection the problem of Heterocedasticity?
- What is the best remedy to remove the Heterocedasticity problem?

- Will simulation, analyzing and remedying corresponding data in the same manner give the same results?

1.3. Importance of Research: -

The importance of this research come from determining the best detection test and the best remedy for the problem of Heterocedasticity, and this in turn gives statistical indicators that have importance in influencing strategic planning. Also from its identification of the simulation method and its link to the multiple linear regression model.

1.4. Objective of Research:

The research firstly aims to:

- study all common detection tests for problem of Heterocedasticity
- applying all remedies to it in the multiple linear regression model
- comparing them with each other
- finding interpretations between the variables, and proving or denying the reliability of the study results by comparing the actual data results with the simulation data.

The second goal is to apply the study in a process of economic importance by studying the government expenditures by identifying the most important factors affecting it.

1.5. Data of Research:

These data were taken from the Ministry of Finance and Economic Planning, Central Bank of Sudan, Central Bureau of Statistics, Ministry of Investment and the Ministry of Trade from period 1977 to 2018.

1.6. Research Hypotheses:

1. There is no significant differences for the estimated multiple linear regression model of the original model
2. There are no significant differences for the multiple linear regression model estimated for the simulated model
3. There are no significant differences for the common detection methods for the problem of Heterocedasticity when applied to the original data
4. There are no significant differences for the common detection methods for the problem of Heterocedasticity when applied to the simulated data
5. There are no significant differences for the remedies methods for the problem of Heterocedasticity when applied to the original data.

6. There are no significant differences for the remedies methods for the problem of Heterocedasticity when applied to the simulated data.

1.7. Methodology of Research:

Descriptive and analytical method was used in this research by describing and analyzing data using multiple linear regression by using statistical packages (SPSS) Version 20, (E.Views) and (Excel v.10) for actual and simulation data, the actual data were included (government expenditures, GDP, inflation, money supply and exchange rate) which were we collected from the Ministry of Finance and Economic Planning, Central Bank of Sudan and the Central Bureau of Statistics in the period from 1977 to 2018, we estimated an original model and tested its significance and then tested the problem of Heterocedasticity with all common detection methods and applied all remedies, the results that we obtained put into comparison tables, the same methodology was repeated on the simulation data and also its results were put in comparison tables and then the two results were compared.

1.8. Previous Studies:

1. Yasser Mustafa Mohammad Al-Hassan in 2018 at Sudan University of Science and Technology, College of Science, Department of Statistics was conducted a study entitled: Estimating and Analysis the Factors Affecting Gross Domestic Product using linear models, he was explained that the ability of the explanatory model of the phenomenon under study depends largely on the appropriateness of assessing the model parameters for economic standards and standards Statistical, and among the most important results of the researcher:

a- When getting rid of the Auto-correlation problem, the method of slowing down the dependent variable (after making two slowdowns) was better than the general difference method and the first difference method.

b- The significance of the value of t calculated after eliminating the problems of economic measurement for most of the independent variables, which indicates the quality of the estimated equations. (Mohammad, 2018)

2. Etidal Musa Youssef Musa in 2018 at Sudan University of Science and Technology, College of Science, Department of Statistics was conducted a study entitled: Detection and Remedy of Heterocedasticity for inflation data in Sudan for the period (1990-2016). She was focused to Heterocedasticity as one of important

problem that we have to remedy it to get good prediction model, and among the most important results of the researcher:

a-When using the logarithmic conversions method, the problem of Heterocedasticity was eliminated.

b- After performing the remedy, we find that the parameter values, standard errors, test and the level of significance in the remedied model differ from the values in the original model, with the decision remaining the same for testing the effect of variables on inflation.

The study also recommended:

a- Using Eviews to test the problem of Heterocedasticity of contrast to reduce the error, as it contains many tests to detect this problem, and it is easy to use and its results are accurate.

b- Conducting more studies on the problem of Heterocedasticity to the extent of error, because there are no studies that have dealt with this problem separately (Musa, 2018).

3. Mohammad Ahmad Mohammad Hassan in 2015 at Sudan University of Science and Technology, College of Science, Department of Statistics was conducted a study entitled: Effect of using aggregation method in solving Auto-correlation & Heterocedasticity problems of multiple linear regression, where data were simulated that suffer from the problems of Auto-correlation and Heterocedasticity, and the aggregation method was applied to The data simulated by a number of different categories to test the effect of different aggregation processes on the problems of Auto-correlation and Heterocedasticity that the original data suffers from. The study concluded with reliability in the method of aggregation as it can be adopted as a new method used in remedying the problems of Auto-correlation and Heterocedasticity. The study recommended using aggregation method, not only because it reduces the material cost and saves effort, but also because it works to improve the data specifications, and then better results are reached upon analysis. The study also recommended paying attention to the aggregation method and making more studies of it so that it can be included as one of the methods used in remedying simple and multiple linear correlation problems (Hassan, 2018).

4. Al-Tayeb Omar Ahmed and Khaled Rahmatullah khedir at Sudan University of Science and Technology, College of Science, Department of Statistics they were published a scientific paper entitled: The Impact of Regression Problems on Estimation by Applying to Profits in Sudanese Banks, where the researchers

touched upon the study of regression problems on the estimation process by analyzing profits in Sudanese banks using linear regression models represented In the problem Heterocedasticity and the problem of Auto-correlation, and the problem of linear interference, and among the most important results that:

a- The logarithm method used in dealing with the problem of linear interference led to the solution of the problem, and this indicates the importance of this method as an additional method for other methods.

b- The contribution of all independent variables to profits is 67%, and that there are 33% of the variables not included in the model that also contribute to profits (Ahmed, khedir, 2014).

5. Salim Akkoun at Université Farhat Abbas – Sétif, Algeria was prepared a study entitled "Measuring the impact of economic variables on the unemployment rate - a standard study - the case of Algeria," which deals with the concept of standard economic models in general and the multiple linear regression model in particular, detailing the model in the application side and its problems and the most important results that he got:

• Unemployment rates are greatly influenced by the size of the total population and the actual GDP

• The inflation rate variable does not appear in the models, due to the fact that there is no clear relationship between the unemployment rate and inflation in Algeria in the long term and therefore changes in the inflation rate do not affect the unemployment rates.

The study recommended the work to provide a database and accurate statistics on the labor market so that each sector is analyzed in addition to developing and supporting the role of the private sector to create job opportunities. It also recommended the necessity of controlling the economic factors and variables that directly or indirectly affect the rate and size of unemployment, study its development and forecast With their values in future periods to take various necessary measures that will reduce unemployment, as well as the need to pay attention to mathematical, statistical and standard methods of economic phenomena such as the phenomenon of inflation and unemployment, for building standard models for them in order to analyze and predict their values (Akkoun, 2010).

6. Dr. Farid Khalil Al-Jakoni at the University of Damascus, Faculty of Economics, Department of Statistics, prepared a study using the method of

multiple linear regression analysis to study the most important economic, social and demographic variables affecting the total birth rate from an applied study based on the data of the 2006 Human Development Assessment for 177 countries Where the researcher began dividing the countries into four groups according to the value of the Human Development Index (HDI) as follows (1) the group of economically advanced countries, most of which are European countries and North America, where the development index is located between (1 - 0.80) and group (2) where it is located The index (0.8-0.601) and group (3) the value of the index in it (0.6-0.401) and the group (4) group of poor countries in East Timor, Zambia, Yemen, Ethiopia, Congo, and others, and it falls (0.4-0.201)

Among the most important results of his study:

• The significant population percentage variable for the age group less than 15 years in the whole group of countries, ie

• The population ratio variable for the age group less than 15 years is the only variable affecting the group of countries (1) and the group of countries (4) and the insignificance of the other variables on these two groups

• The significance of the education variable and its correlation inversely with (TFR) is the total birth rate in the group of countries (3 and 2) and the lack of Significance for countries (4 and 1). Our explanation to this is that the group of developed countries (1) has exceeded the phase of the effect of the education variable in (TFR) While groups (3 and 2) are in the phase of a variable effect (TFR) and the fourth group has not yet entered the phase of the education variable effect in (TFR) due to the low percentage of education in this group of countries (Al-Jakoni, 2008).

7. Ikram Ubaid Fadlallah Saad at Sudan University of Science and Technology, College of Science, Department of Statistics was conducted a study entitled: The effect of aggregation on solving the problem of Heterocedasticity (it was applied to the simple linear regression model). The study reached many results, the most important of which is that the aggregation process works to change the data specifications as it reduces Differences between the observations, so there is no gap for the values to be dispersed to a large degree. Therefore, the aggregation process eliminated the problem of Heterocedasticity between the collections that were created in the original data with a number of different categories (Saad, 2004).

Similarities and Differences between this study and the previous studies:

The previous studies focused only on a certain method of detection or remedy, while this study relied on all common detections and remedies methods as a comparison study between actual data and other simulated data corresponding to it.

1.9. Research Structure:

The research included five chapters, where the first chapter contain the introduction of research, research problem, its importance, objectives, data, hypotheses, research methodology and some previous studies, and the second chapter contain the conceptual framework deals with the concept of econometrics in general through the multiple linear regression model, problems, methods of detection and remedying them in addition to the concept of simulation, while the third chapter dealt of national income with the government expenditures and important variables affecting it, and then the fourth chapter dealt the application and discussions which the analytical side of the research data, and finally the fifth chapter was contained the results and recommendations, references and appendices.

Chapter Two

Conceptual Framework

Conceptual Framework:

2.1. Linear Regression Model

Linear regression model, or linear model in statistics, is a statistical model used to interpret a variable y via another variable x or (some variables $x_1, x_2, ..., x_k$ according to a linear function (Ismail, 2006, pp. 15-19).

A variable y is called the dependent variable and x_k variables are independent or explained variables, meaning that they statistically explain the change of the dependent variable.

It is divided into two types:

a. Simple linear regression as it consists of one dependent variable and one independent variable

b. Multiple linear regressions consisting of dependent variable and several independent variables (Ronald E, 2007).

2.2. Multiple Linear Regression Model (MLR):

The multiple linear model consists of k independent variables $\mathrm{x}_1, \mathrm{x}_2, ..., \mathrm{x}_\mathrm{k}$. It takes the following form:

$$Y_i = \beta_o + \beta_1 X_{1i} + \beta_2 X_{2i} + ... + \beta_k X_{ki} + U_i \qquad (2\text{-}1)$$

Based on formula (1), there are $(k+1)$ parameters that are required to be estimated. That is, there are a number of similar equations that can be written as the following formula:

$$\left.\begin{array}{l} i = 1 \Rightarrow Y_1 = \beta_o + \beta_1 X_{11} + \beta_2 X_{21} + ... + \beta_k X_{k1} + U_1 \\ i = 2 \Rightarrow Y_2 = \beta_o + \beta_1 X_{12} + \beta_2 X_{22} + ... + \beta_k X_{k2} + U_2 \\ \vdots \\ i = n \Rightarrow Y_n = \beta_o + \beta_1 X_{1n} + \beta_2 X_{2n} + ... + \beta_k X_{kn} + U_n \end{array}\right\} \qquad (2\text{-}2)$$

Equation (4-2) can be written in matrix by the vector as follows:

$$, \underline{U} = \begin{bmatrix} U_1 \\ U_2 \\ \vdots \\ U_n \end{bmatrix}_{n\times1} , \underline{\beta} = \begin{bmatrix} \beta_0 \\ \beta_1 \\ \vdots \\ \beta_n \end{bmatrix}_{(\mathrm{k}+1)\times1} \underline{Y} = \begin{bmatrix} Y_1 \\ Y_2 \\ \vdots \\ Y_n \end{bmatrix}_{n\times1} \underline{X} = \begin{bmatrix} 1 & X_{11} & X_{21} \cdots X_{k1} \\ 1 & X_{12} & X_{22} \cdots X_{k2} \\ \vdots & & \\ 1 & X_{1n} & X_{2n} \cdots X_{kn} \end{bmatrix}_{n\times(k+1)} \qquad (2\text{-}3)$$

Where the matrix $\underline{X}$ is the independent variables

So it can be written briefly as follows:

$\underline{Y} = \underline{X}\,\underline{\beta} + \underline{U}$ (2-4)

Where (2-3) is the General Linear Regression (GLM) (Alrawi, 1987)

2.3. Coefficient of determination

The coefficient of determination (goodness of fit) R^2 of a multi-linear model can be calculated from the correlation coefficient between measured and estimated values. It indicates how well the model equation fits the data.

However, the goodness of fit depends not only on the quality of fit but also on the number of observations and the number of variables. The goodness of fit can be deliberately brought towards 1.0 simply by including an increasing number of variables (descriptors) into the model equation (statistics4u, 2021). So that is, the ratio of the contribution of the dependent variable to bringing about changes in the explanatory variables.

2.4. Problems of Regression Model:

The problems facing the linear regression model are represented in several forms, including heterogeneity of variance, self-correlation, and multiple linear interference in three main problems:

a. Heteroksceasticity

b. Autocorrelation between U_i's

c. Multicollinearity (Ibrahim et al, 2002, pp. 151-279)

We should point out here which this research focusing into the Heteroksceasticity

2.5. Heterocedasticity

One of the most important hypotheses of the model, as it is known, is that the error term u_i present in the regression function must be homogeneous, meaning that they all have the same value of variance. Violation of this hypothesis is known as the Heterocedasticity problem. It should be noted here that the phenomenon of Heterocedasticity of variance affects estimates of the variance of model estimators and that the tests used as the t test and the F test in this case become unactualistic and unreliable (Samprit, Ali, 2006).

Failure to fulfill the assumption of variance homogeneity, results in:

a. The inapplicability of the formulas for estimators' variances $\hat{Y}_i$ ،$\hat{\beta}_1$ $\hat{\beta}_0$

b. If the error variance is homogeneous, then the least squares estimators will have the least variance even though they remain unbiased estimators.

c. Predictions in variable Y based on $\hat{\beta}$'s from the original data will have large variations (Ibrahim et al, 2002, pp. 205-206).

2.6. Detection of Heterocedasticity:

The Heterocedasticity of the variance is detected by several tests, including the following:

2.6.1. Breuch-Pagan Godfry Test

To explain this test, let us consider a regression model that includes an independent variable k as in equation (2-1), i.e.

$$Y_i = \beta_o + \beta_1 X_{1i} + \beta_2 X_{2i} + \ldots + \beta_k X_{ki} + U_i$$

Suppose that the error variance σ_i^2 is defined as follows:

$$\sigma_i^2 = f\,(\alpha_1 + \alpha_2 Z_{2i} + \ldots + \alpha_m Z_{mi}) \qquad (2\text{-}5)$$

That is means σ_i^2 is a function of some non-random variable Z's some of X's can handle it as Z's in particular, suppose that:

$$\sigma_i^2 = \alpha_1 + \alpha_2 Z_{2i} + \ldots + \alpha_m Z_{mi} \qquad (2\text{-}6)$$

That is σ_i^2 a linear function of Z's if $\alpha_2 = \alpha_3 = \ldots = \alpha_m = 0$ then $\sigma_i^2 = \alpha_1$ and it is constant. Hence to test whether σ_i^2 is a constant contrast, we can test that: $\alpha_2 = \alpha_3 = \ldots = \alpha_m = 0$ and this is the basic idea behind the Breuch Pagan test.

The actual test follows the following steps:

i. Estimate (2-2) using OLS and get the residuals $\hat{u}_1, \hat{u}_2, \cdots, \hat{u}_n$

ii. Get $\tilde{\sigma}_i^2 = \sum \hat{u}_i^2 / n$

iii. Create a variable $p_i = \hat{u}_i^2 / \tilde{\sigma}^2$ that simply expresses the squares of the residuals divided by $\tilde{\sigma}^2$

iv. Fit regression p_i on Z's

$$p_i = \alpha_1 + \alpha_2 Z_{2i} + \ldots + \alpha_m Z_{mi} + v_i \qquad (2\text{-}7)$$

Where v_i represents the residual term in this regression

v. Get SSE (sum of error squares) and define the following:

$$\Theta = \frac{1}{2}(\text{SSR})$$

Assuming that the u_i up to normal distribution, it can be shown that if there is a constant variance and assuming an increase in the sample size n then:

$\Theta \sim \chi^2_{m-1}$ (2-8)

That is Θ up to chi-square distribution in degrees of freedom $(m-1)$, and therefore if the researcher finds that the computed value Θ greater than critical value X_2 at the specified level of significance value, then the hypothesis of constancy of variance can be rejected, otherwise the null hypothesis is not rejected (T.Breusch, Pagan, 1979).

2.6.2. Harvey-Godfrey LM

Was developed by Harvey in 1976 and Godfrey in 1978 . In order to perform this test, a sequence of complementary steps have to be implemented. First of all, in order to obtain the disturbances $\hat{u}_i$, we run a regression of the same initial equation like in the case of Breusch-Pagan LM test and Park LM test, respectively as like equation (2-1)

The next step involves computing the following auxiliary regression:

$$\ln \hat{u}_i^2 = a_1 + a_2 Z_{2t} + a_3 Z_{3t} + ... + a_p Z_{pt} + v_i \qquad (2\text{-}9)$$

The null hypothesis of Homoskedasticity has the following expression :

$H_o : a_1 = a_2 = \cdots = a_p$

The alternative hypothesis H_1 is as formula

$H_o : a_1 \neq a_2 \neq \cdots \neq a_p$

The following step is to compute the $LM = nR^2$ statistic, where n the number of observations is established to determine the auxiliary regression and R^2 is the coefficient of determination of this particular regression. The LM statistical follows the χ^2 distribution characterized by $p-1$ degrees of freedom. The last step assume to reject the null hypothesis and to highlight the presence of Heterocedasticity when LM-statistical is higher than the critical value (Birãu, 2012).

In other words, if $LM_{Stat} \rangle \chi^2_{p-1}$ we reject null hypothesis then there is no Heterocedasticity

2.6.3. Glejser Test:

The Glejser Test is spiritually similar to the park Test. After we get the residuals from the OLS regression, Glejser suggests that we do a regression of the absolute values of the variable, which he assumes is highly correlated with. In his experiments, Glejser uses the following forms of functions:

$$
\left.
\begin{aligned}
|\hat{u}_i| &= \beta_1 + \beta_2 X_i + v_i \\
|\hat{u}_i| &= \beta_1 + \beta_2 \sqrt{X_i} + v_i \\
|\hat{u}_i| &= \beta_1 + \beta_2 \frac{1}{X_i} + v_i \\
|\hat{u}_i| &= \beta_1 + \beta_2 \frac{1}{\sqrt{X_i}} + v_i \\
|\hat{u}_i| &= \sqrt{\beta_1 + \beta_2 X_i} + v_i \\
|\hat{u}_i| &= \sqrt{\beta_1 + \beta_2 X_i^2} + v_i
\end{aligned}
\right\} \text{Where } v_i \text{ is error term} \qquad (2\text{-}10)
$$

Again, in actual or practical terms, it is possible for the researcher to use the method of Glejser, indicating that the error term v_i may have some problems, as its expected value is not zero, it is series related and of course it will have a difference in variance.

An additional difficulty with the Glejser method is that the models such as:

$$
\begin{aligned}
|\hat{u}_i| &= \sqrt{\beta_1 + \beta_2 X_i} + v_i \\
|\hat{u}_i| &= \sqrt{\beta_1 + \beta_2 X_i^2} + v_i
\end{aligned}
\qquad (2\text{-}11)
$$

Models are nonlinear in features and thus cannot be estimated by the normal OLS method.

Glejser found that for large samples, the first four models generally give satisfactory results for detecting variance. In practice, the Glejser method can be used for large samples, while small samples should be used according to certain restrictions to be a good quantitative tool for detecting variance of variance (H.Glejser, 1969, pp. 316 – 322).

2.6.4. Auto-Regressive Conditional Heterocedasticity (ARCH LM) Test:

ARCH models allow for the modeling of variants containing non-constant conditional covariance of random errors. So this test is based on the lagrange multiplier LM. The test steps are as follows:

a. Estimate the general model $Y = X\beta + \varepsilon$ by using the OLS method, and then calculates the squares of residuals $\hat{\varepsilon}_t^2$.

b. Estimate the following equation:

$$\hat{\varepsilon}_t^2 = \theta_\circ + \theta_1 \hat{\varepsilon}_{t-1}^2 \cdots + \theta_q \hat{\varepsilon}_{t-q}^2 + u_t$$

With the calculation of the coefficient of determination R^2 of this equation. In this case we lose q observations.

c. So the conditional variance hypothesis of errors H_o that should be tested are:

$$H_o = \theta_o = \theta_1 = \cdots = \theta_q = 0$$

Statistic of Lagrange multiplier $LM = (n-q) \times R^2$ up to χ^2 distribution with a degree of freedom q, if $(n-q) \times R^2$ it is greater than $\chi^2_{\mathrm{d.f=(q)}}$ (the critical value of χ^2 distribution with a significant ratio α), we reject H_o, If there is at least one parameter of the ARCH equation that differs significantly from zero then the conditional variance of residuals is not homogeneous (Sheikhi, 2011).

2.6.5. White Test

The general test for Heterocedasticity suggested by White comes which is not dependent on normalization assumption and is easy to apply, and to explain the basic idea behind this test, let's consider the following regression model, which includes three variables (the general case, which is represented in a model that includes the variable k is a direct extension and narrowing of this case Own).

$$Y_i = \beta_\circ + \beta_1 X_{1i} + \beta_2 X_{2i} + u_i \qquad (2\text{-}12)$$

The steps for the White test are as follows:

a. According to the data, we estimate equation (4-9) and obtain the residuals.

b. Then we do the following (auxiliary regression):

$$\hat{u}_i^2 = \alpha_1 + \alpha_2 X_{2i} + \alpha_3 X_{3i} + \alpha_4 X_{2i}^2 + \alpha_5 X_{3i}^2 + \alpha_6 X_{2i} X_{3i} + v_i \qquad (2\text{-}13)$$

That is, we do a regression for the squares of the residuals from the original regression on the original X variables. Get R^2 from this auxiliary regression.

c. Under the validity of the null hypothesis, which says that there is no difference in the variance, it can be proven that it is the result of multiplying the sample size (n) with R^2 that we obtained from the auxiliary regression which roughly translates into the quadratic chi-Square distribution with degrees of freedom equal to the number of the regression variables (excluding the constant part) in the auxiliary regression, i.e. that:

$$n.R^2 \underset{asy}{\sim} \chi^2_{df} \qquad (2\text{-}14)$$

Where $d.f$ is defined as we defined before. In our current example there are 5 degrees of freedom, as there are 5 regression variables.

d. If the value of chi-squared that we obtained from (2-14) exceeds the value of chi-squared at the specified level of significance, then we conclude that there is a difference in variance, that is, in the auxiliary regression (2-12) we find that: $\alpha_2 = \alpha_3 = \alpha_4 = \alpha_5 = \alpha_6 = 0$ (H.White, 1980, pp. 817 – 818).

2.6.6. Park Test:

Park developed the graphical method as a formal method for detecting variance. So he supposed that σ_i^2 is a function of some variable in the explanatory variable x_i. The functional form that he suggested is:

$$\sigma_i^2 = \sigma^2 X_i^{\beta} e^{vi}$$

or

$$\ln \sigma_i^2 = \ln \sigma^2 + \beta \ln X_i + v_i \qquad (2\text{-}15)$$

Where v_i is the error term

Since σ_i^2 is generally unknown, Park suggested using $\hat{u}_i^2$ as an alternative, and did the following regression:

$$\ln \hat{u}_i^2 = \ln \sigma^2 + \beta \ln X_i + v_i$$
$$= \alpha + \beta \ln X_i + v_i \qquad (2\text{-}16)$$

If β is statistically significant, then this means that there is a problem of Heterocedasticity in the data under study. If it is not significant, then we accept the null hypothesis (assumption of constancy of variance).

So the Park test in this way is done in two stages. The first stage applies the regression of the OLS while ignoring the question about whether or not the difference in variance, we get $\hat{u}_i$ from this regression, and then we enter the second stage and apply a regression as in equation (2-16) (E.Park, 1966, p. 888).

2.6.7. Spearman's Rank Correlation Coefficient Test:

This test is considered the simplest type of test for Heterocedasticity and can be applied in the case of both small and large samples. Spearman's correlation coefficient is used instead of the Pearson correlation coefficient, due to the fact that Pearson's correlation coefficient between the estimated random error $\hat{u}_i$ and the independent variable X_i is zero based on one of the assumptions of the regression model. The linearity of the random variable being independent of the independent variable

For Simple Regression:

In this case, the Heterocedasticity is detected by the following steps:

a- After estimating the model parameters, it is obtained $\widehat{Y_i} = \widehat{\beta}_0 + \widehat{\beta}_1 X_i$ Hence the residuals e_i , which is an estimate of the random variable U_i , where: $e_i = Y_i - \widehat{Y_i}$

b- Taken the absolute values of the residuals $|e_i|$, that is, then the coefficient of rank correlation r_s between the independent variable X_i and r_s is calculated according to the following formula:

$$r_s = 1 - \frac{6\sum d^2_i}{n(n^2-1)} \qquad (2\text{-}17)$$

Where d_i : represent the differences between the ranks of the corresponding pairs of X_i and $|e_i|$.

c- Calculate the value of the t-test for the rank correlation coefficient r_s according to the following formula:

$$t = \frac{r_s\sqrt{n-2}}{\sqrt{1-r^2_s}} \qquad (2\text{-}18)$$

We compare the calculated value of t with the tabulated value $t_{n-2,\frac{\alpha}{2}}$. If the computed is less or equal to the tabulated value, then we accept the null hypothesis and there is no Heterocedasticity, but if the computed value is greater than the tabulated value, then we reject the null hypothesis and accept the alternative, that is, the random error variance is not homogeneous.

For Multiple Regression:

a. Fit the multiple linear regression model as follow:

$$\widehat{Y_i} = \widehat{\beta}_0 + \widehat{\beta}_1 X_{1i} + \widehat{\beta}_2 X_{2i} + \dots + \widehat{\beta}_k X_{ki}$$

From it we calculate the residual values e_i where $e_i = Y_i - \widehat{Y_i}$

b. We calculate the ranks correlation coefficient for each independent variable with $|e_i|$, in other words, we will compute k from the ranks correlation coefficients for $(|e_i|, X_{1i}), (|e_i|, X_{2i}), \dots, (|e_i|, X_{ki})$

c. We test each r_s coefficient according to the following formula:

$$t = \frac{r_s \sqrt{n-k-1}}{\sqrt{1-r^2_s}} \qquad (2\text{-}19)$$

The calculated value is compared with the tabulated value $t_{n-k-1,\frac{\alpha}{2}}$, if it is proven that it is at least one of the significant values (rejecting the null hypothesis), then this indicates the Heterocedasticity, but if all are not significant (acceptance of the null hypothesis) then that is evidence that the random error variance is homogeneous (Ibrahim et al, 2002, pp. 206-209).

2.6.8. Gold-field Quandt Test:

It is used separately, whether in multiple linear regression or simple linear regression, the number of observations must be at least equal to twice the number of parameters in the model, according to the following steps:

- The X values are arranged in ascending order, and accordingly the order of the Y values will change.
- A set of observations from the sample center with a number of c is neglected, so c is equal to a quarter of a number of observations i.e.:

$c \cong \frac{1}{4}n$ Hence the rest of sample become $n-c$ and their number is even, divided into two groups, each group is equal $\frac{n-c}{2}$

- We consider that the two groups are independent, estimate for the first group a linear regression model and from it we calculate $\sum_{i=1}^{\frac{n-c}{2}} e^2_{1i}$ also for the second group, we also estimate the linear regression model and from it we calculate $\sum_{i=1}^{\frac{n-c}{2}} e^2_{1i}$ so d.f of error for each group become $\frac{n-c}{2}-k-1$were k Number of independent variables.
- We calculate F test from the following formula:

$$F = \frac{\max\left(\hat{\sigma}^2_{u1}, \hat{\sigma}^2_{u2}\right)}{\min\left(\hat{\sigma}^2_{u2}, \hat{\sigma}^2_{u2}\right)} \qquad (2\text{-}20)$$

Knowing that:

$$\hat{\sigma}_{u1}^2 = \sum e^2_{1i} \Big/ \left(\frac{n-c}{2} - k - 1\right) \quad , \quad \hat{\sigma}_{u2}^2 = \sum e^2_{2i} \Big/ \left(\frac{n-c}{2} - k - 1\right)$$

And since the degrees of freedom in the two groups are equal therefore:

$$F = \frac{\max\left(\sum e^2_{1i}, \sum e^2_{2i}\right)}{\min\left(\sum e^2_{1i}, \sum e^2_{2i}\right)} \qquad (2\text{-}21)$$

The value of the computed F is compared with the tabulated at the two degrees of freedom of $\frac{n-c}{2} - k - 1$ for the numerator and $\frac{n-c}{2} - k - 1$ for the denominator and the level of significance α. The following cases are noted:

a. If it is $\left(\sum e^2_{1i} > \sum e^2_{2i}\right)$, meaning that $\hat{\sigma}_{u1}^2 > \hat{\sigma}_{u2}^2$ and $F = \frac{\hat{\sigma}_{u1}^2}{\hat{\sigma}_{u2}^2}$, and we assume that the null hypothesis is rejected, then this means that the first group with small X values has a variance of error greater than the variance of error of the second group in which the large X values are, in other words that the variance of the error is inversely proportional With increasing values of the independent variable.

b. If it is $\left(\sum e^2_{2i} > \sum e^2_{1i}\right)$, meaning that $\hat{\sigma}_{u2}^2 > \hat{\sigma}_{u1}^2$ and $F = \frac{\hat{\sigma}_{u2}^2}{\hat{\sigma}_{u1}^2}$, and we assume that the null hypothesis is rejected, this means that the first group in which the small X values have a variance of error less than the variance of error of the second group in which the large X values are, in other words that the error variance is directly proportional to the increase in the values of the independent variable X .

c. If the null hypothesis is accepted, meaning that $\sum e^2_{1i} = \sum e^2_{2i}$, then the error variance is homogeneous (Ibrahim et al, 2002, pp. 216-217).

2.7. Remedies of Heterocedasticity:

The remedy of Heterocedasticity via transformation of the original model is performed, and the form of the transformation of the original model depends on the Heterocedasticity pattern in the estimated original model.

The original model is assumed to be as follows:

$$Y_i = \beta_o + \beta_1 X_i + U_i$$

There are several patterns (assumptions) for the Heterocedasticity, and the converted model or equation differs from one assumption to another.

2.7.1 First Assumption:

$$\sigma_{ui}^2 = \sigma_u^2 X_i^2 \qquad (2\text{-}22)$$

To remedy Heterocedasticity in this case, the original form is divided by X_i (the square root of the coefficient of ∂_u^2 in equation (2-22) as follows:

$$\frac{Y_i}{X_i} = \frac{\beta_o}{X_i} + \beta_1 + \frac{U_i}{X_i} \qquad (2\text{-}23)$$

We notice that the new error term in Model (2-23) is $\frac{U_i}{X_i}$, which is homogeneous because:

$$V\left(\frac{U_i}{X_i}\right) = E\left(\frac{U_i}{X_i}\right)^2 - \left[E\left(\frac{U_i}{X_i}\right)\right]^2$$

$$= \frac{1}{X_i^2} E(U_i)^2 - \frac{1}{X_i^2}\left[E(U_i)\right]^2$$

$$= \frac{1}{X_i^2}\sigma_{ui}^2 - \frac{1}{X_i^2}0 = \frac{1}{X_i^2}\sigma_{ui}^2 X_i^2 = \sigma_u^2$$

After estimating the model (2-23) it results:

$$\frac{\hat{Y_i}}{X_i} = \frac{\hat{\beta}_o}{X_i} + \hat{\beta}_1 \qquad (2\text{-}24)$$

We notice that in this model, the constant term is $\hat{\beta}_1$, while the slope is $\hat{\beta}_o$, on the contrary, in the estimated original model, and to return to the estimated original model, the model (2-12) is multiply by X_i (Ibrahim et al, 2002, p. 220).

2.7.2. Second Assumption:

$$\sigma_{ui}^2 = \sigma_u^2 X_i \qquad (2\text{-}25)$$

To remedy Heterocedasticity in this case, the original model is divided by $\sqrt{X_i}$, and it can be verified that the problem has been eliminated by observing the following:

$$\frac{Y_i}{\sqrt{X_i}} = \frac{\beta_o}{\sqrt{X_i}} + \beta_1\sqrt{X_i} + \frac{U_i}{\sqrt{X_i}} \qquad (2\text{-}26)$$

$$V\left(\frac{U_i}{\sqrt{X_i}}\right) = E\left(\frac{U_i}{\sqrt{X_i}}\right)^2 - \left[E\left(\frac{U_i}{\sqrt{X_i}}\right)\right]^2$$

$$= \frac{1}{X_i} E(U_i)^2 - \frac{1}{X_i}\left[E(U_i)\right]^2$$

$$= \frac{1}{X_i}\sigma_{ui}^2 - \frac{1}{X_i} 0 = \frac{1}{X_i}\sigma_{ui}^2 X_i = \sigma_u^2$$

After estimating the model (2-26) we get:

$$\frac{\hat{Y_i}}{\sqrt{X_i}} = \frac{\hat{\beta}_o}{\sqrt{X_i}} + \hat{\beta}_1 \sqrt{X_i} \qquad (2\text{-}27)$$

Note that this model represents a MLR model without a segment. To return to the original estimated model, multiply (2-28) by $\sqrt{X_i}$ (Ibrahim et al, 2002, p. 221).

2.7.3. Third Assumption:

$$\sigma_{ui}^2 = \sigma_u^2 \left[E\left(\hat{Y_i}\right)\right]^2 \qquad (2\text{-}28)$$

To remedy Heterocedasticity in this case, the original form is divided by $E\left(\hat{Y_i}\right)$, i.e. $\beta_o + \beta_1 X_i$, and we get:

$$\frac{Y_i}{\beta_o + \beta_1 X_i} = \frac{\beta_o}{\beta_o + \beta_1 X_i} + \frac{\beta_1}{\beta_o + \beta_1 X_i} + \frac{U_i}{\beta_o + \beta_1 X_i} \qquad (2\text{-}29)$$

To make sure that the phenomenon has been eliminated, we calculate the variance of the error in the model (4-26), and we find that:

$$V\left(\frac{U_i}{\beta_o + \beta_1 X_i}\right) = E\left(\frac{U_i}{\beta_o + \beta_1 X_i}\right)^2 - \left[E\left(\frac{U_i}{\beta_o + \beta_1 X_i}\right)\right]^2$$

$$= \frac{1}{(\beta_o + \beta_1 X_i)^2} E(U_i)^2 - \frac{1}{(\beta_o + \beta_1 X_i)^2}\left[E(U_i)\right]^2$$

$$= \frac{1}{(\beta_o + \beta_1 X_i)^2}\sigma_{ui}^2 - \frac{1}{(\beta_o + \beta_1 X_i)^2} 0 = \frac{\sigma_{ui}^2 (\beta_o + \beta_1 X_i)^2}{(\beta_o + \beta_1 X_i)^2} = \sigma_u^2 \qquad (2\text{-}30)$$

After estimating the model (2-29), and for returning to the original estimated model, the equation is multiplied by $(\beta_o + \beta_1 X_i)$, so we obtain a regression model that does not suffer from the phenomenon of Heterocedasticity (Ibrahim et al, 2002, p. 221).

2.7.4. Fourth Assumption:

$$\sigma_{ui}^2 = \sigma_u^2 \left|e_i\right| \qquad (2\text{-}31)$$

To remedy Heterocedasticity in this case, the original form is divided by $\sqrt{|e_i|}$, it can be verified that the phenomenon has been eliminated by observing the following:

$$\frac{Y_i}{\sqrt{|e_i|}} = \frac{\beta_o}{\sqrt{|e_i|}} + \frac{\beta_1 X_i}{\sqrt{|e_i|}} = \frac{U_i}{\sqrt{|e_i|}} \qquad (2\text{-}32)$$

The variance of new error term $\frac{U_i}{\sqrt{|e_i|}}$ become as follow:

$$V\left(\frac{U_i}{\sqrt{|e_i|}}\right) = E\left(\frac{U_i}{\sqrt{|e_i|}}\right)^2 - \left[E\left(\frac{U_i}{\sqrt{|e_i|}}\right)\right]^2$$

$$= \frac{1}{\sqrt{|e_i|}} E\,(U_i)^2 - \frac{1}{\sqrt{|e_i|}}\left[E\,(U_i)\right]^2$$

$$= \frac{1}{\sqrt{|e_i|}} E\,(U_i)^2 = \frac{1}{\sqrt{|e_i|}} \sigma_u^2 \sqrt{|e_i|} = \sigma_u^2 \qquad (2\text{-}33)$$

After estimating the model (2-32), and for returning to the original estimated model, the equation is multiplied by $\sqrt{|e_i|}$, so we get model without Heterocedasticity (Ibrahim et al, 2002, p. 222).

2.7.5. Fifth Assumption:

It is a logarithmic transfer, as it is known that taking the logarithms of the values leads to the convergence of these values from each other, and this means a decrease in the variance of the values. In this assumption the logarithms of the values of the two variables are taken and we get the following regression model:

$$\log Y_i = \beta_o + \beta_1 \log X_i + U_i \qquad (2\text{-}34)$$

This model is estimated by the OLS method to be devoid of Heterocedasticity (Ibrahim et al, 2002, p. 223).

2.7.6. Sixth Assumption (Researcher suggestion):

The Researcher suggested: $\sigma_{ui}^2 = \sigma_u^2\left[E(\hat{y})\right]$

According to it we will divided all original variables by $\sqrt{\hat{y}}$, it can be verified that the phenomenon has been eliminated by observing the following:

$$\frac{Y_i}{\sqrt{\hat{y}}} = \frac{\beta_o}{\sqrt{\hat{y}}} + \frac{\beta_1 X_i}{\sqrt{\hat{y}}} = \frac{U_i}{\sqrt{\hat{y}}} \qquad (2\text{-}35)$$

The variance of new error term $\frac{U_i}{\sqrt{\hat{y}}}$ become as follow:

$$V\left(\frac{U_i}{\sqrt{\hat{y}}}\right)=E\left(\frac{U_i}{\sqrt{\hat{y}}}\right)^2-\left[E\left(\frac{U_i}{\sqrt{\hat{y}}}\right)\right]^2$$

$$=\frac{1}{\sqrt{\hat{y}}}E\left(U_i\right)^2-\frac{1}{\sqrt{\hat{y}}}\left[E\left(U_i\right)\right]^2$$

$$=\frac{1}{\sqrt{\hat{y}}}E\left(U_i\right)^2=\frac{1}{\sqrt{\hat{y}}}\sigma_u^2\sqrt{\hat{y}}=\sigma_u^2 \qquad (2\text{-}36)$$

After estimating the model (2-35), and for returning to the original estimated model, the equation is multiplied by $\sqrt{\hat{y}}$, so we get model without Heterocedasticity

2.7.7. Seventh Assumption (general case):

In all of the previous cases:

$$\sigma_{ui}^2=\sigma_u^2 f\left(X_i\right) \qquad (2\text{-}37)$$

Therefore, in order to eliminate Heterocedasticity of the random variable U, all the terms of the original regression model are divided by the square root of the coefficient σ_u^2, i.e. by $\sqrt{f\left(X_i\right)}$ (Ibrahim et al, 2002, p. 223).

2.8 Simulation Concept:

The great development in computers and the existence of simulation programs with a high degree of flexibility and ease of use made the use of simulation in solving industrial, economic, social, medical and environmental problems an easy matter to the extent that there are many scientists who reformulated a lot of applied sciences and verified their validity, depending on simulation methods. And simulation is one of the important means to solve problems, problem solving techniques, and it is the only and last way to solve any problem if it is difficult to solve it by analytical methods or numerical methods. The simulation depends on methods of resampling methods and the generation of numbers and random variables with specific characteristics (Berri, 2002).

Simulation models allow obtaining information, such as mean or median or confidence intervals, on variables that do not have an exact value, but for which we either know or assume a distribution. If some “result” variables depend on these “distributed” variables by the way of known or assumed formulae, then the “result” variables will also have a distribution. Simulation allows you to define the distributions, and then to obtain, through simulations, an empirical distribution of the input and output variables as well as the corresponding statistics.

Simulation models are used in many areas such as finance and insurance, medicine, oil and gas prospecting, accounting, or sales prediction (xlstat, 2021).

2.8.1 Definition of Simulation:

Simulation is an imitation or representation of the action of a actual system over a specified period of time. Whether we run the simulation manually or using a computer, it includes the generation of an artificial history of the system in order to infer the operational properties of the actual system (Berri, 2002, p. 14).

It is also defined as a mathematical method for treating and implementing dilemmas in the computer, in which certain types of mathematical and logical relationships necessary to describe the behavior and form of a system for a complex actual world and for long periods of time overlap, and the simulation process begins by building a model for the problem under study, then implementing experiments and solutions for the complex numerical model.

2.8.2 Advantages of Simulation:

i. Simulation enables the study and experimentation of the internal interactions of any complex system or part of that system.

ii. Economic, financial, social and environmental changes can be simulated and observed for this modification of the model's behavior.

iii. By changing the simulation inputs and observing the resulting outputs, we can identify the important variables in the actual system and the way in which they interact.

iv. From the modeling and simulation process we obtain very useful information to improve the performance of the actual system

v. Simulations are used to support many of the theoretical research findings.

2.8.3 Disadvantages of Simulation:

i. Building a model needs experience and special training, but some say that building a model is an art, as not everyone who learns to write calligraphy becomes a calligrapher, and in the case of giving the same problem to two different people, each of them may build a model for that and there are things in common between the two resulting models, but the differences Large and the two models will not be applicable.

ii. The results of the simulation or its outputs may be difficult to interpret, especially if the inputs are random, which results in random outputs, and thus it is difficult to know whether the resulting differences are from randomness or from an actual interaction between the variables.

iii. Modeling, analysis and collecting data for the purpose of simulation takes a very long time and is sometimes costly, as the shortening or cutting off some sources in the model building process results in an incomplete model that is not applicable to the actual system and its results become useless (Berri, 2002, pp. 14 - 16).

2.8.4 Simulation Steps:

A simulation of a system is the operation of a model of the system; "Simulation Model". The steps involved in developing a simulation model, designing a simulation experiment, and performing simulation analysis are:

Step1. Identify the Problem:

Enumerate problems with an existing system. Produce requirements for a proposed system.

Step 2. Formulate the Problem:

Select the bounds of the system, the problem or a part thereof, to be studied. Define overall objective of the study and a few specific issues to be addressed. Define performance measures – quantitative criteria on the basis of which different system configurations will be compared and ranked. Identify, briefly at this stage, the configurations of interest and formulate hypotheses about system performance. Decide the time frame of the study. Identify the end-user of the simulation model.

Step 3. Collect and Process Actual System Data:

Collect data on system specifications, input variables, as well as the performance of the existing system.

Step 4. Formulate and Develop a Model:

Develop schematics and network diagrams of the system. Translate these conceptual models to simulation software acceptable form. Verify that the simulation model executes as intended. Verification techniques include traces, varying input parameters over their acceptable range and checking the output, substituting constants for random variables and manually checking results, and animation.

Step 5. Validate the Model:

Compare the model's performance under known conditions with the performance of the actual system. Perform statistical inference tests and get the model examined by system experts. Assess the confidence that the end user places on the model and address problems if any.

Step 6. Document Model for Future Use:

Document objectives, assumptions and input variables in detail. Document the experimental design.

Step 7. Select Appropriate Experimental Design:

Select a performance measure, a few input variables that are likely to influence it, and the levels of each input variable. Generally, in stationary systems, steady-state behavior of the response variable is of interest. Ascertain whether a terminating or a nonterminating simulation run is appropriate. Select the run length. Select appropriate starting conditions. Select the length of the warm-up period, if required. Decide the number of independent runs – each run uses a different random number stream and the same starting conditions – by considering output data sample size. Sample size must be large enough (at least 3-5 runs for each configuration) to provide the required confidence in the performance measure estimates. Alternately, use common random numbers to compare alternative configurations by using a separate random number stream for each sampling process in a configuration. Identify output data most likely to be correlated.

Step 8. Establish Experimental Conditions for Runs:

Address the question of obtaining accurate information and the most information from each run. Determine if the system is stationary (performance measure does not change over time) or non-stationary (performance measure changes over time).

Step 9. Perform Simulation Runs:

Perform runs according to steps 7-8 above.

Step 10. Interpret and Present Results:

Compute numerical estimates (e.g., mean, confidence intervals) of the desired performance measure for each configuration of interest. Test hypotheses about system performance. Construct graphical displays (e.g., pie charts, histograms) of the output data. Document results and conclusions.

Step 11. Recommend Further Courses of Action:

This may include further experiments to increase the precision and reduce the bias of estimators, to perform sensitivity analyses, etc.

Although this is a logical ordering of steps in a simulation study, much iteration at various sub-stages may be required before the objectives of a simulation study are achieved. Not all the steps may be possible and/or required. On the other hand, additional steps may have to be performed (Maria, 1997).

2.8.5 Some software packages used in modeling simulation:

2.8.5.1 Microsoft Excel:

Microsoft Excel is a spreadsheet developed by Microsoft for Windows, macOS, Android and iOS. It features calculation, graphing tools, pivot tables, and a macro programming language called Visual Basic for Applications (VBA). It has been a very widely applied spreadsheet for these platforms, especially since version 5 in 1993, and it has replaced Lotus 1-2-3, as the industry standard for spreadsheets. Excel forms part of the Microsoft Office suite of software (Wikipedia, 2021).

Excel 2016 has 484 functions. Of these, 360 existed prior to Excel 2010. Microsoft classifies these functions in 14 categories. Of the 484 current functions, 386 may be called from VBA as methods of the object "WorksheetFunction" and 44 have the same names as VBA functions.

A simulation in Excel must be built around a model, and that is defined by a system of formulas and mathematical operations. A simple multiplication operation can be a model, as well as a workbook full of complex formulas and macros. All that matters is the model's ability to mimic the actual-time process that it's used to solve (Adam, 2018).

2.8.5.2 ARENA

Arena is discrete event simulation and automation software developed by Systems Modeling and acquired by Rockwell Automation in 2000. It uses the SIMAN processor and simulation language (Wikipedia, 2020).

2.8.5.3 GPSS

General Purpose Simulation System (GPSS) is a discrete time simulation general-purpose programming language, where a simulation clock advances in discrete steps. A system is modeled as transactions enter the system and are passed from one service (represented by blocks) to another. It is used primarily as a process flow oriented simulation language; this is particularly well-suited for problems such as a factory (Thesen, J. William, 2014).

Chapter Three

Concept of Government Expenditures

3.1. Concept of National Income:

National income is one of the important and widespread economic concepts in the world of economics, so there is hardly any economic conference or meeting of specialists in the economy in the country or even students specialized in this field from using the term national income. The study of national income and understanding what this term means will help to understand many economic matters that are intertwined and intertwined with each other, and national income is the third measure of economic output, which is the sum of labor incomes and other elements of production that arise from the current production of goods and services in the economy (Abdjman, 2010) also National income means the value of goods and services produced by a country during a financial year. Thus, it is the net result of all economic activities of any country during a period of one year and is valued in terms of money. National income is an uncertain term and is often used interchangeably with the national dividend, national output, and national expenditure. We can understand this concept by understanding the national income definition (toppr, 2019).

3.2. National Income Definition:

According to Marshall: “The labor and capital of a country acting on its natural resources produce annually a certain net aggregate of commodities, material and immaterial including services of all kinds. This is the true net annual income or revenue of the country or national dividend.”

The definition as laid down by Marshall is being criticized on the following grounds.

Due to the varied category of goods and services, a correct estimation is very difficult.

There is a chance of double counting; hence National Income cannot be estimated correctly.

For example, a product runs in the supply from the producer to distributor to wholesaler to retailer and then to the ultimate consumer. If on every movement commodity is taken into consideration then the value of National Income increases.

Also, one other reason is that there are products which are produced but not marketed.

For example, in an agriculture-oriented country like India, there are commodities which though produced but are kept for self-consumption or exchanged with other commodities. Thus there can be an underestimation of National Income.

Simon Kuznets defines national income as "the net output of commodities and services flowing during the year from the country's productive system in the hands of the ultimate consumers."

3.3. Importance of National Income:

The following points highlight the top eleven reasons for growing importance of national income studies in recent years. The reasons are: 1. Economic Policy 2.Economic Planning 3. Economy's Structure 4.Inflationary and Deflationary Gaps 5.Budgetary Policies 6.National Expenditure, 7.Distribution of Grants-in-aid and Others.

3.3.1. Economic Policy:

National income figures are an important tool of macroeconomic analysis and policy, national income estimates are the most comprehensive measures of aggregate economic activity in an economy. It is through such estimates that we know the aggregate yield of the economy and can lay down future economic policy for development.

3.3.2. Economic Planning:

National income statistics are the most important tools for long-term and short-term economic planning. A country cannot possibly frame a plan without having a prior knowledge of the trends in national income.

3.3.3. Economy's Structure:

National income statistics enable us to have clear idea about the structure of the economy. It enables us to know the relative importance of the various sectors of the economy and their contribution towards national income. From these studies we learn how income is produced, how it is distributed, how much is spent, saved or taxed**.**

3.3.4. Inflationary and Deflationary Gaps:

National income and national product figures enable us to have an idea of the inflationary and deflationary gaps. For accurate and timely anti- inflationary and deflationary policies, we need regular estimates of national income.

3.3.5. Budgetary Policies:

Modern governments try to prepare their budgets within the framework of national income data and try to formulate anti-cyclical policies according to the facts revealed by the national income estimates. Even the taxation and borrowing policies are so framed as to avoid fluctuations in national income.

3.3.6. National Expenditure:

National income studies show how national expenditure is divided between consumption expenditure and investment expenditure. It enables us to provide for reasonable depreciation to maintain the capital stock of a community. Too liberal allowance of depreciation may prove harmful as it may unnecessarily lead to a reduction in consumption.

3.3.7. Distribution of Grants-in-aid:

National income estimates help a fair distribution of grants-in-aid by the federal governments to the state governments and other constituent units.

3.3.8. Standard of Living Comparison:

National income studies help us to compare the standards of living of people in different countries and of people living in the same country at different times.

3.3.9. International Sphere:

National income studies are important even in the international sphere as these estimates not only help us to fix the burden of international payments equitably amongst different nations but also enable us to determine the subscriptions and quotas of different countries to international organizations like the UNO, IMF, IBRD. Etc.

3.3.10. Defense and Development:

National income estimates help us to divide the national product between defense and development purposes. From such figures we can easily know how much can be spared for war by the civilian population.

3.3.11. Public Sector:

National income figures enable us to know the relative roles of public and private sectors in the economy. If most of the activities are performed by the state, we can easily conclude that public sector is playing a dominant role (Pal, 2021).

3.4. Government Expenditures:

Includes all government consumption, investment, and transfer payment (Bureau of Economic Analysis, 2010). In national income accounting, the acquisition by governments of goods and services for current use, to directly satisfy the individual or collective needs of the community, is classed as government final consumption expenditure. Government acquisition of goods and services intended to create future benefits, such as infrastructure investment or research spending, is classed as government investment (government gross capital formation). These two types of government spending; on final consumption and on gross capital formation, together constitute one of the major components of gross domestic product (Wikipedia, 2021)

Government spending can be financed by government borrowing, or taxes. When Governments choose to borrow money, they have to pay interest on the money borrowed which can lead to government debt **(**National Priorities Project, 2020**)**

3.5. The most important variables affecting on the Government Expenditures:

3.5.1 Gross Domestic Product (GDP):

It is the sum of the market values of the final goods and services produced in all countries during a period of time (usually a year). The methods of calculating the gross domestic product are determined. In other words, it is the market value of all the final goods and services locally recognized that are produced in a country during a specific period of time. GDP per capita is often taken as an indicator of a country's standard of living. GDP per capita is not a measure of per capita income. Under economic theory, GDP per capita is exactly equal to gross domestic income per capita (GDI). GDP relates to the national accounts, which is a subject of macroeconomics. GDP should not be confused with gross national product (GNP), which allocates production by ownership (Lequiller and others, 2006).

3.5.1.1 Determining gross domestic product (GDP):

GDP can be determined in three ways, all of which should, theoretically, give the same result. They are the production (or output or value added) approach, the income approach, or the speculated expenditure approach.

The most direct of the three is the production approach, which sums the outputs of every class of enterprise to arrive at the total. The expenditure approach works on the principle that all of the product must be bought by somebody, therefore the value of the total product must be equal to people's total expenditures in buying things. The income approach works on the principle that the incomes of the Productive factors ("producers", colloquially) must be equal to the value of their product, and determines GDP by finding the sum of all producers' incomes (World Bank, 2009)

3.5.2. Inflation:

In economics, inflation (or less frequently, price inflation) is a general rise in the price level in an economy over a period of time (Blanchard, 2000), When the general price level rises, each unit of currency buys fewer goods and services; consequently, inflation reflects a reduction in the purchasing power per unit of money – a loss of actual value in the medium of exchange and unit of account within the economy (Walgenbach, 1973, p. 429).

The common measure of inflation is the inflation rate, the annualized percentage change in a general price index, usually the consumer price index, over time (Mankiw, 2002, pp. 22–32).

3.5.3. Money Supply:

In macroeconomics, the money supply (or money stock) is the total value of money available in an economy at a point of time. There are several ways to define "money", but standard measures usually include currency in circulation and demand deposits (depositors' easily accessed assets on the books of financial institutions). (Brunner, 2018, p. 527)

Historically, large infusions of gold or silver into an economy had led to inflation. For instance, when silver was used as currency, the government could collect silver coins, melt them down, mix them with other metals such as copper or lead and reissue them at the same nominal value, a process known as debasement. At the ascent of Nero as Roman emperor in AD 54, the denarius contained more than 90% silver, but by the 270s hardly any silver was left. By diluting the silver with other metals, the government could issue more coins without increasing the amount of silver used to make them. When the cost of each coin is lowered in this way, the government profits from an increase her ownership (Royal Canadian Mint, 2006, p.4).

This practice would increase the money supply but at the same time the relative value of each coin would be lowered. As the relative value of the coins becomes lower, consumers would need to give more coins in exchange for the same goods and services as before. These goods and services would experience a price increase as the value of each coin is reduced and that interpret the relationship between money supply and inflation so the central bank of each country may use a definition of what constitutes money for its purposes.

Money supply data is recorded and published, usually by the government or the central bank of the country. Public and private sector analysts monitor changes in the money supply because of the belief that such changes affect the price levels of securities, inflation, the exchange rates, and the business cycle (Federal Reserve Bank of New York, 2021)

3.5.4. Exchange Rate:

In finance, an exchange rate is the rate at which one national currency will be exchanged for another. It is also regarded as the value of one country's currency in relation to another currency (O'Sullivan, Steven M, 2003)

Each country determines the exchange rate regime that will apply to its currency. For example, a currency may be floating, pegged (fixed), or a hybrid. Governments can impose certain limits and controls on exchange rates. In floating exchange rate regimes, exchange rates are determined in the foreign exchange market (Levinson, 2005) which is open to a wide range of different types of buyers and sellers, and where currency trading is continuous: 24 hours a day except weekends (Sudan announced a managed floatation of its currency on February 2021) (Associated Press, 2021).

3.5.4.1 Exchange rate classification:

a. From the perspective of bank foreign exchange trading:
    - Buying rate: Also known as the purchase price, it is the price used by the foreign exchange bank to buy foreign currency from the customer. In general, the exchange rate where the foreign currency is converted to a smaller number of domestic currencies is the buying rate, which indicates how much the country's currency is required to buy a certain amount of foreign exchange.
    - Selling rate: Also known as the foreign exchange selling price, it refers to the exchange rate used by the bank to sell foreign exchange to customers. It indicates how much the country's currency needs to be recovered if the bank sells a certain amount of foreign exchange.
    - Middle rate: The average of the bid price and the ask price. Commonly used in newspapers, magazines or economic analysis.

b. According to the length of delivery after foreign exchange transactions:
    - Spot exchange rate: Refers to the exchange rate of spot foreign exchange transactions. That is, after the foreign exchange transaction is completed, the exchange rate in Delivery within two working days. The exchange rate that is generally listed on the foreign exchange market is generally referred to as the spot exchange rate unless it specifically indicates the forward exchange rate.

- Forward exchange rate: To be delivered in a certain period of time in the future, but beforehand, the buyer and the seller will enter into a contract to reach an agreement. When the delivery date is reached, both parties to the agreement will deliver the transaction at the exchange rate and amount of the reservation. Forward foreign exchange trading is an appointment-based transaction, which are due to the different time the foreign exchange purchaser needs for foreign exchange funds and the introduction of foreign exchange risk. The forward exchange rate is based on the spot exchange rate, which is represented by the “premium”, “discount”, and “parity” of the spot exchange rate.

c. According to the method of setting the exchange rate:
   - Basic rate: Usually choose a key convertible currency that is the most commonly used in international economic transactions and accounts for the largest proportion of foreign exchange reserves. Compare it with the currency of the country and set the exchange rate. This exchange rate is the basic exchange rate. The key currency generally refers to a world currency, which is widely used for pricing, settlement, reserve currency, freely convertible, and internationally accepted currency.
   - Cross rate: After the basic exchange rate is worked out, the exchange rate of the local currency against other foreign currencies can be calculated through the basic exchange rate. The resulting exchange rate is the cross exchange rate.

3.5.4.2 Factors affecting the change of exchange rate:

a. Balance of payments: When a country has a large international balance of payments deficit or trade deficit, it means that its foreign exchange earnings are less than foreign exchange expenditures and its demand for foreign exchange exceeds its supply, so its foreign exchange rate rises, and its currency depreciates.
b. Interest rate level: Interest rates are the cost and profit of borrowing capital. When a country raises its interest rate or its domestic interest rate is higher than the foreign interest rate, it will cause capital inflow, thereby increasing the demand for domestic currency, allowing the currency to appreciate and the foreign exchange depreciate.

c. Inflation factor: The inflation rate of a country raises the purchasing power of money declines, the paper currency depreciates internally, and then the foreign currency appreciates. If both countries have inflation, the currencies of countries with high inflation will depreciate against those with low inflation. The latter is a relative revaluation of the former.
d. Fiscal and monetary policy: Although the influence of monetary policy on the exchange rate changes of a country's government is indirect, it is also very important. In general, the huge fiscal revenue and expenditure deficit caused by expansionary fiscal and monetary policies and inflation will devalue the domestic currency. The tightening fiscal and monetary policies will reduce fiscal expenditures, stabilize the currency, and increase the value of the domestic currency.
e. Venture capital: If speculators expect a certain currency to appreciate, they will buy a large amount of that currency, which will cause the exchange rate of that currency to rise. Conversely, if speculators expect a certain currency to depreciate, they will sell off a large amount of the currency, resulting in speculation. The currency exchange rate immediately falls. Speculation is an important factor in the short-term fluctuations in the exchange rate of the foreign exchange market.
f. Government market intervention: When exchange rate fluctuations in the foreign exchange market adversely affect a country's economy, trade, or the government needs to achieve certain policy goals through exchange rate adjustments, monetary authorities can participate in currency trading, buying or selling local or foreign currencies in large quantities in the market. The foreign exchange supply and demand has caused the exchange rate to change.
g. Economic strength of a country: In general, high economic growth rates are not conducive to the local currency's performance in the foreign exchange market in the short term, but in the long run, they strongly support the strong momentum of the local currency.

Chapter Four

Application & Discussion

4. Application and Discussion:

First, a sufficiency test was applied for the model and a description of the variables, followed by estimating the equation of the standard model by including all the variables on it, and detecting them with all methods of detection and remedying them with all remedial methods and measuring the merits of each model to choose the best method of detection methods and the best remedy for each problem in the first model, Then the same steps in previous were applied in a simulated model corresponding to the actual data according to the normal distribution based on parameters (Mean & St.deviation) for each variable by simulated variable by Microsoft Excel.

Firstly: For Original Model:

4.1. Description of study variables:

Year: The Years here fall in period (from 1977 to 2018)

EXPE: Government Expenditures (dependent variable)

GDP: gross domestic product (First independent variable)

INF: Inflation (Second independent variable)

MS: money supply (Third independent variable represents)

EXCH_Of: Exchange Rate (Fourth independent variable)

According to the Mean and Std.Deviation for each variable we simulated data corresponding to the actual above data with sample size 42 observations (like actual data sample size), we assumed the simulated variables can be as follow:

EXPE_s: Government Expenditures (simulated dependent variable)

GDP_s: gross domestic product (First simulated independent variable)

INF_s: Inflation (Second simulated independent variable)

MS_s: money supply (Third simulated independent variable represents)

EXCH_Of_s: Exchange Rate (Fourth simulated independent variable)

4.2. Sufficiency Test for actual data:

Hypothesis of the sufficiency was tested by Kaiser-Meyer-Olkin (K M O) test, which values fall between 0 – 1. KMO measures the sampling adequacy which should be greater than 0.5 (TÜRKMEN, 2009)

So by applying it to the study data, we get:

Table (4 - 1) Test value (K M O) for Actual Model

Test	value	d.f	Sig. value
K M O	0.728	10	0.000

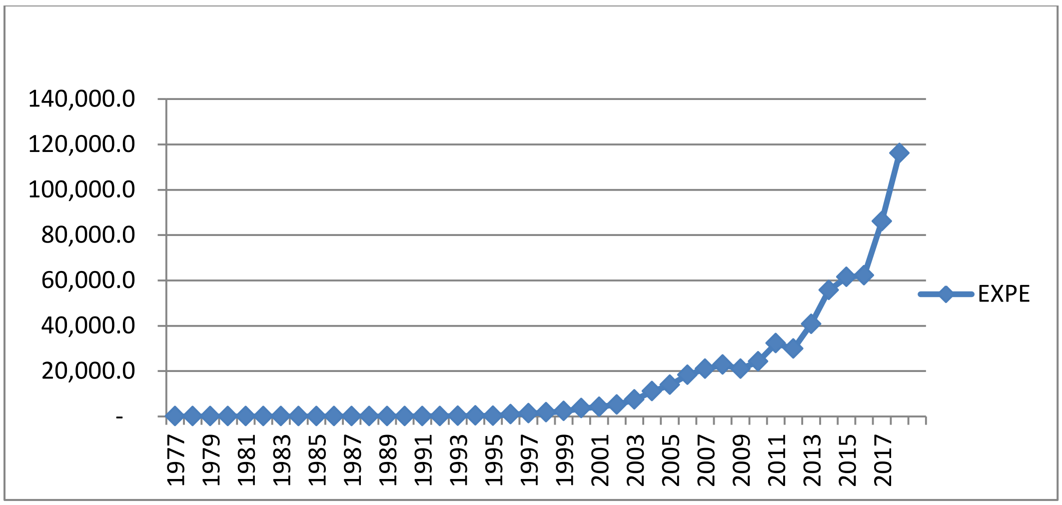
Source: Researcher preparation 2020 using SPSS V. 20

From table (4 - 1) we note that the test value is (0.728) and it falls within the range (0.5 - 1). Therefore, the data is sufficient for the test, and what confirms that it is the significance of the probability value which is equal to (0.000) which is less than 0.05.

4.3. Description of the study variables for actual data:

4.3.1 Description of the Expenditure Variable (EXPE):

Figure (4 - 1): Description of the Expenditure Variable (EXPE)

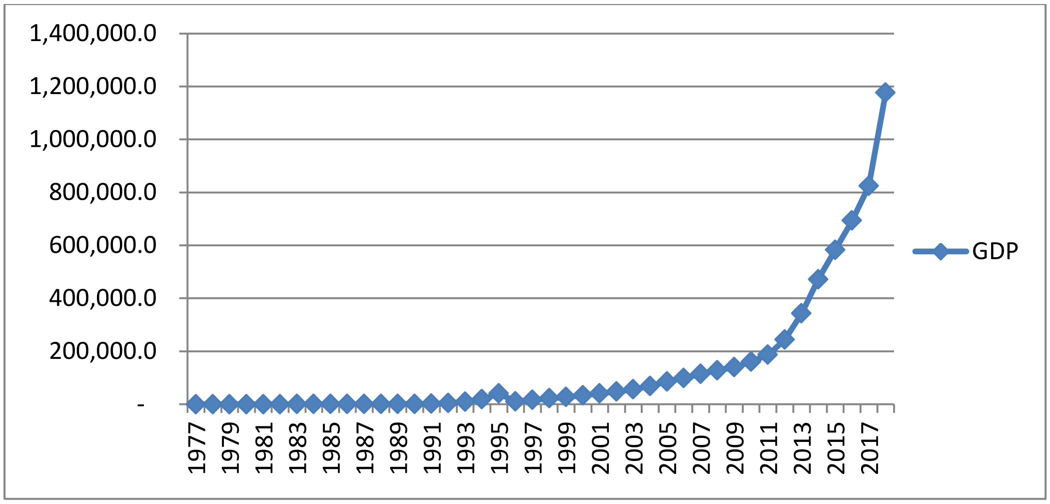


Source: Researcher preparation 2020 using Excel v.10

We note that from Figure (4 - 1) the expenditure variable remained almost stable in the period from 1977 until 1999, and starting from 2005 the expenditure increases until 2011, as this is attributed to the signing of the Comprehensive Peace Agreement and the formation of two governments at that time; one in the north of Sudan and the other in the south of Sudan, which expanded the state's general budget, and consequently expenditures increased and decreased slightly in 2012 after the secession (Warren, 2011), then increased steadily until the end of the time period due to inflation and the loss of some revenue resources.

4.3.2 Description of the Gross Domestic Product Variable (GDP):

Figure (4 - 2): Description of the Gross domestic product Variable (GDP)

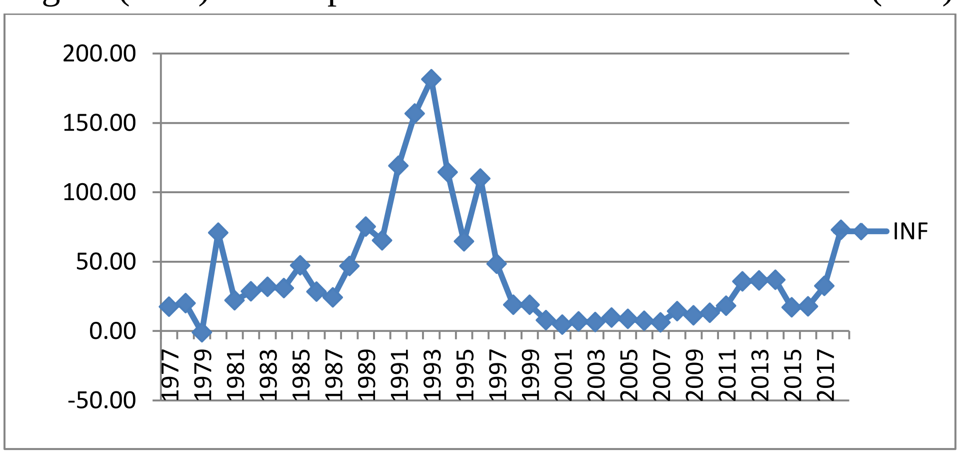


Source: Researcher preparation 2020 using Excel v.10

It is noticed from Figure (4 - 2) above that the variable of GDP remained almost stable and witnessed clear growth in the year 1995 and remained stable and gradually increased until the end of the study period, but the actual start was in the year 2005, during the signing of the Comprehensive Peace Agreement (CPA was an accord signed on January 9, 2005, by the Sudan People's Liberation Movement (SPLM) and the Government of Sudan).

4.3.3 Description of the inflation variable (INF):

Figure (4 - 3): Description of the of the inflation variable (INF)

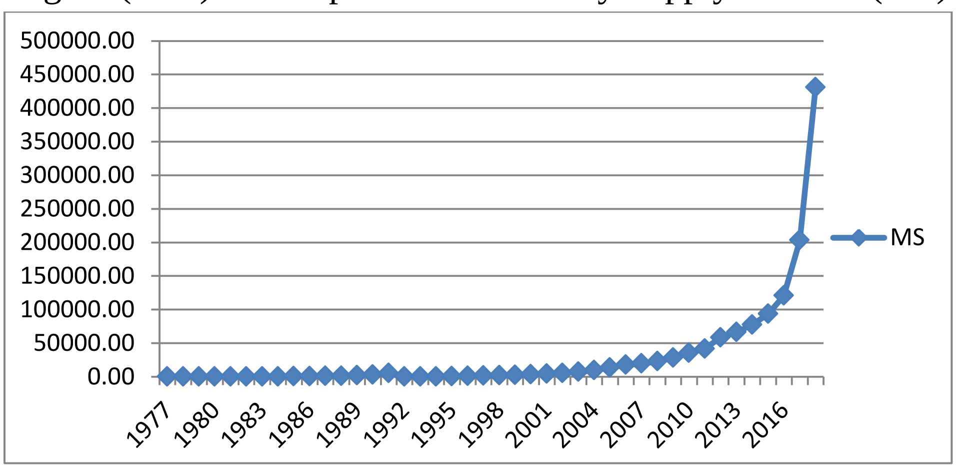


Source: Researcher preparation 2020 using Excel v.10

From Figure (4 - 3) we note that the inflation variable remained fluctuating between 1977 and 2000, due to the succession of governments, political fluctuations and civil wars. However, from 2005 to 2011, it witnessed relative stability due to the Comprehensive Peace Agreement (CPA) that was signed then and resumed fluctuations until the end of the time period due to the secession of the south Sudan, as Sudan lost 75% of its oil revenues, and the government turned to fiscal and devaluation of the Sudanese currency, which raised the costs of imports and thus increased inflation austerity (Austerity a set of political-economic policies that aim to reduce government budget deficits through spending cuts, tax increases, or a combination of both (Wikipedia,2021bgy)).

4.3.4 Description of the Money Supply variable (MS):

Figure (4 - 4): Description of the Money Supply variable (MS)

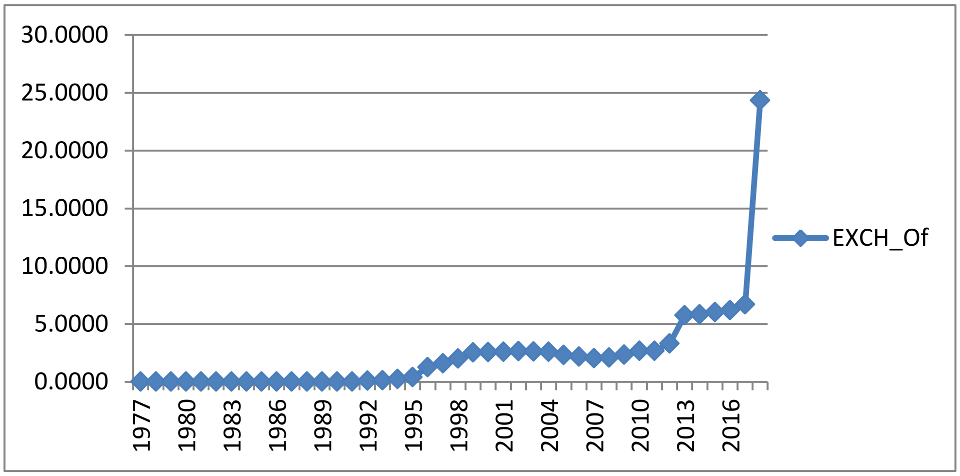


Source: Researcher preparation 2020 using Excel v.10

From Figure (4 - 4) it is noticed that the money supply (MS) variable remained stable from the beginning of the time period until the year 2005, after which it witnessed an increase (an increase in the money supply) until the end of the time period, it should be noted here that from the year 2005 until 2011 the increase in the money supply was logical because of the economic growth at the time, but after the separation of south Sudan, the government resorted to printing more money to fill the deficit in the public budget, and accordingly the money supply increased.

4.3.5 Description of the Exchange rate variable (EXCH_Of):

Figure (4 - 5): Description of the Exchange rate variable (EXCH_Of)



Source: Researcher preparation 2020 using Excel v.10

From Figure (4 - 5) we note that the Exchange Rate variable remained stable from 1977 to 1995, after which it witnessed an increase to become semi-stable until 2011 and increased in 2013 and stabilized to start in the year 2015 due to the government's resort to devaluing the currency at that time from 8 SDG to 15 SDG, It reached its peak in the year 2018 due to the policy of the market makers mechanism of the shock policy (U.S. dollar skyrockets as Sudan adopts new mechanism to set exchange rate," October 7, 2018, (Sudan Tribune, 2018)), which the government adopted at the time as it devalued the national currency, so the exchange rate reached 47.5 pounds and continued unceasingly (SDG is ISO 4217of the Sudanese pound (ISO 4217 is a standard published by International Organization for Standardization (ISO) that defines alpha codes and numeric codes for the representation of currencies and provides information about the relationships between individual currencies and their minor units (Wikipedia,2021)).

4.4. Descriptive Statistics of the study variables of actual data:

Table (4 - 2): Descriptive Statistics of the study variables of actual data

Variable	Mean	Std.deviation	C.V	Minimum	Maximum
EXPE	15326.3	26183.53	1.71	0.5	116090
GDP	134478.6	255024.27	1.9	23.4	1176630
INF	43.26	42.89	0.99	4.4	181.47

Variable	Mean	Std.deviation	C.V	Minimum	Maximum
MS	30642.78	74942.59	2.45	53.19	430786
EXCH_Of	2.28	4.01	1.76	0.0004	24.35

Source: Researcher preparation 2020 using SPSS V. 20

From Table (4 - 2) the following is noted:

- Average of Expenditures is (15326.30) with a standard deviation (26183.53); the minimum value (0.5) was registered in the year 1979 and the maximum value is (116090) was in the year 2018.
- As for the average GDP (134478.60), with a standard deviation (255024.27); the minimum value (23.4) was registered in 1977 and the largest value was (1176630) in 2018.
- Average inflation was (43.26) with a standard deviation (42.89); the minimum value (4.4) was registered in 2001 and the maximum value was (181.47) in 1993.
- As for the average money supply (30642.78) with a standard deviation (74942.59); the minimum value (53.19) was registered in 1977 and the maximum value was (430786) in 2018.
- The average exchange rate reached (2.28) with a standard deviation (4.01); the minimum value was (0.0004) and it was registered in 1977, 1978 and 1979 and the maximum value was (24.35) in 2018.

We used the coefficient of variation (CV) due to variation of units.

4.5. Estimation of MLR of the original model and its significance test:

Firstly: Estimate MLR of the Original model:

Table (4 - 3): Estimate MLR of the Original model

Model	Coefficient	St.Error	t-Statistic	Prob.	R^2
GDP	0.107169	0.007929	13.51695	0.0000	0.979
INF	-27.6605	16.20234	-1.70719	0.0962	
MS	-0.03971	0.042295	-0.93893	0.3539	
EXCH	349.0648	564.8257	0.618004	0.5404	
C	2457.567	1188.081	2.068518	0.0456	

Source: Researcher preparation 2020 using EViews 9

According to Table (4 - 3), the estimated model equation will be as follows:

$$\widehat{EXPE} = 2457.57 + 0.107\ GDP - 27.660\ INF - 0.0397\ MS + 349.065\ EXCH$$

• Interpretation of the model parameters:

$\hat{\beta}_o$: Its value (2457,567) is interpreted as the average dependent variable EXPE (expenditures) when the value of the independent variables (GDP, inflation, money supply and exchange rate) is equal to zero, that is, without taking into account the effect of the other independent variables.

$\hat{\beta}_1$: If the independent variable GDP (gross domestic product) increases by one million SDG, then the EXPE variable (expenditures) increases by (0.107169) million SDG with the stability of the rest of the other independent variables. Thus the relationship between GDP and EXPE is a direct relationship.

$\hat{\beta}_2$: If the independent variable INF (inflation) increases by 1%, then the EXPE variable (expenditures) decreases by (27.6605) %, with stability of the rest of the other independent variables, indicating an inverse relationship between INF and EXPE.

Likewise, if the independent variable MS (money supply) increases by one million SDG, then the EXPE variable (expenditures) decreases by (0.03971) SDG with the stability of the rest of the other independent variables, and the relationship between MS and EXPE also is a direct relationship.

$\hat{\beta}_3$: Likewise, if the independent variable MS (money supply) increases by one million SDG, then the EXPE variable (expenditures) decreases by (0.03971) SDG with the stability of the rest of the other independent variables, and the relationship between MS and EXPE also is a direct relationship

$\hat{\beta}_4$: If the independent variable EXCH_Of (the exchange rate) increases by one SDG, then the EXPE variable (expenses) increases by an amount of (349.0648) SDG with the rest of the other independent variables' stability; meaning that the relationship between EXCH and EXPE is a direct relationship.

• The value of the coefficient of determination (R^2) equals (0.979), which is a very large percentage that explains that the percentage of the independent variables (GDP, INF, MS, EXCH) in causing changes in the dependent variable (EXPE) is 97.9%, while 0.021 is due to measurement errors.

Secondly: Test of Significance for the Original Model:

We will test the following hypotheses:

H_o: The Model is Significance

Against

H_1: The Model is No Significance

We form the ANOVA (Analysis of variance (ANOVA) is a collection of statistical models and their associated estimation procedures (such as the "variation" among and between groups) used to analyze the differences among group means in a sample (Wikipedia, 2020)) analysis table as follows:

Table (4 - 4): table of Analysis of variance for the Original estimated model (ANOVA)

Model	d.f	Mean Square	Mean Square	F	Sig.
Regression	4	27513434244	6878358561	427.56	0.000
Residual	37	595235862.5	16087455.7		
Total	41	28108670107	-		

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 4) we note the following:

- F-test value equal to (427.56)
- The significance value is equal to (0.000) and since it is less than (0.05), we reject the null hypothesis and accept the alternative hypothesis, which is that the model is significant, i.e. the significance of the effect of the independent variables on the dependent variable

4.6. Detection of Heterocedasticity for the actual Model:

The hypothesis to be tested here is:

$H_o : \text{U}_i \text{ 's } are \text{ hom} oscedastic$

$Against$

$H_1 : \text{U}_i \text{ 's } are\ heteroscerdastic$

4.6.1. Breusch - Pagan - Godfrey Test for actual Model:

Table (4 - 5): Breusch - Pagan - Godfrey test results for actual model

Test	F-statistic	Prob-Value	S.E. of regression	Akaike info criterion	R^2
Breuch - Pagan godfrey	3.0258	0.0349	25321356	37.043	0.25

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 5) it becomes clear that the test value is (3.0258) and the probability value is equal to (0.0349) and it is less than the level of significance (0.05). Therefore, we reject the null hypothesis; meaning that residuals are not homogeneous according to the Breuch - Pagan Godfrey test, which indicates that the test helped in detection of the problem of Heterocedasticity with a determination coefficient (0.25%).

4.6.2. Harvey Test for actual Model:

Table (4 - 6): Harvey test results for actual model

Test	F-statistic	Prob-Value	S.E. of regression	Akaike info criterion	R^2
Harvey	4.050957	0.0123	1.800265	4.125089	0.304561

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 6) it becomes clear that the test value is (4.0509) and the probability value is equal to (0.0123) and it is less than the level of significance (0.05). Therefore, we reject the null hypothesis, meaning that the residuals are not homogeneous, and therefore there is a problem of Heterocedasticity based on the Harvey test with a determination coefficient its value is (0.03).

4.6.3. Glejser Test for actual Model:

Table (4 - 7): Glejser Test Results for actual model

Test	F-statistic	Prob-Value	S.E. of regression	Akaike info criterion	R^2
Glejser	3.993	0.013	2199.61	18.341	0.031

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 7) it becomes clear that the test value is (3.994) and the probability value is equal to (0.0130), which is less than the level of significance (0.05). Therefore, we reject the null hypothesis; meaning that the residuals are not homogeneous, so there is a problem of Heterocedasticity according to the Glejser test, which indicates however that the test assisted in detection with a determination coefficient (0.3).

4.6.4. ARCH LM Test for actual model:

Table (4 - 8): ARCH LM test results for actual model

Test	F-statistic	Prob-Value	S.E. of regression	Akaike info criterion	R^2
ARCH LM	0.3302	0.5688	28242880	37.198	0.0084

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 8) we note that the test value is (0.3302) and the probability value is equal to (0.5688), which is greater than the level of significance (0.05). Therefore, we accept the null hypothesis that means residuals are homogeneous, so there is no problem of Heterocedasticity according to the ARCH LM test with Coefficient of determination value (0.01%).

4.6.5. White Test for Actual Model:

Table (4 - 9): White test results for actual model

Test	F-statistic	Prob-Value	S.E. of regression	Akaike info criterion	R^2
White	4.4272	0.0096	18810243	36.61	0.6966

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 9) it becomes clear that the test value is (4.427) and the probability value is equal to (0.001), which is less than the level of significance (0.05). Therefore, we reject the null hypothesis; meaning that residuals are not homogeneous, so there is a problem of Heterocedasticity according to White's test, meaning that it contributed to detection of the problem with a Coefficient of determination (0.70%).

4.6.6. Park Test for Actual Model:

There is no software package that performs the testing by direct command, but the test can be performed indirectly with SPSS or EViews by the method of transfer functions (see the theoretical side) and here we used EViews and the result is as follows:

Table (4 -10): Park test results for actual model

Test	F-statistic	Prob-Value	S.E. of regression	Akaike info criterion	R^2
Park	8.66455	0.0014	0.379331	0.3842	0.490
		0.0000			
		0.0506			
		0.0027			

Source: Researcher preparation 2020 using EViews

From Table (4 - 10) it becomes clear that the test value is (8.664) and the probability values are equal to (0.0014, 0.0000, 0.0506, 0.0027) respectively, and all of them are less than the level of significance (0.05) except for the value (0.0506), hence we reject the null hypothesis; meaning that the Residuals are Heterocedasticity according to the Park test, which means that the Park test helped in the detection of the problem with a Coefficient of determination (0.49)

4.6.7. Spearman's Rank Correlation Coefficient Test for Actual Model:

After estimating the model and calculating the absolute value of errors, we calculate the coefficient of ranks correlation for each independent variable with the absolute value of the error term, and accordingly there will be 4 parameters as follows (look 2.6.7):

Table (4 - 11): results of the ranks correlation coefficient test for actual model

variable	GDP	INF	MS	EXCH
Correlation Coefficients	0.532	-0.541	0.456	0.469
t test value for r_s	3.822	-3.912	3.117	3.23

Source: Researcher preparation 2020

Compare to:

$$t_{n-k-1,\frac{\alpha}{2}} = t_{37,0.025} = 2.026$$

From Table (4 - 11) we notice that all the calculated values are greater than the tabulated value, and therefore we reject the null hypothesis; meaning that the model suffers from the problem of Heterocedasticity according to Spearman's rank correlation test.

4.6.8. The Gold-Field Quandt Test for Actual Model:

We apply the steps as mentioned in (2.6.8)

$C = \frac{n}{4} = \frac{42}{4}$

First: Group One:

The estimated model will be as follows:

$E\hat{X}PE_1 = 1.911 - 0.0215GDP - 0.129INF + 0.008MS + 2830.96EXCH\_OF$

Accordingly, the estimators will be as shown in Table (4 - 12)

Table (4 - 12): Estimates of the First Group of the Gold-Field Quandt Test for actual model

EXPE	GDP	INF	MS	EXCH_Of	$E\hat{X}PE$	e	e^2
0.8	23.4	17.52	53.19	0.0004	0.68	0.14	0.02
0.6	28.8	19.98	70.59	0.0004	0.40	0.18	0.03
0.5	32.5	-1.04	93.65	0.0004	3.39	-2.90	8.40
1.1	39.7	70.79	123.21	0.0005	-5.60	6.68	44.65
109.4	4,218.2	156.69	141.60	0.1000	175.27	-65.84	4335.40
1.3	49.5	22.02	156.97	0.0007	1.37	-0.09	0.01
1.6	70.4	28.43	216.10	0.0013	2.31	-0.72	0.52
144.9	9,484.5	181.47	268.60	0.1300	144.85	0.05	0.00
1.9	95.9	31.66	277.45	0.0013	1.88	0.00	0.00
2.0	118.1	30.75	326.15	0.0013	1.95	0.02	0.00
321.2	18,812.9	114.50	405.40	0.2200	208.88	112.36	12625.75
2.7	153.6	47.17	601.81	0.0013	1.50	1.21	1.46
215.9	40,497.4	64.55	705.90	0.4000	261.20	-45.30	2052.02
5.5	202.2	28.35	775.60	0.0025	7.82	-2.33	5.42
6.6	364.8	24.05	1040.70	0.0035	10.05	-3.44	11.86
$\sum e_{1i}^2$							**19,085.5**

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We conclude that:

$\sum e_{1i}^2 = 19085.5$ ………………………………. (4-1)

Second: The Second Group:

The estimated model will be as follows:

$$E\hat{XP}E_2 = 8523.71 + 0.081GDP + 208.31INF + 0.056MS - 1106.34EXCH\_OF$$

Accordingly, the estimates will be as shown in Table (4 - 13)

Table (4 - 13): Estimates of the Second group of the Gold-Field Quandt Test for actual model

EXPE	**GDP**	**INF**	**MS**	**EXCH_Of**	$E\hat{XP}E_2$	e	e^2
7,362.0	55,733.8	6.25	7341.00	2.6100	11851.25	-4489.25	20153409.68
11,038.0	68,721.4	9.52	9604.50	2.5800	13742.56	-2704.56	7314635.97
13,847.0	85,707.1	8.59	13782.00	2.3100	15453.03	-1606.03	2579327.56
18,253.0	98,718.8	7.20	17871.80	2.1700	16597.00	1656.00	2742330.18
20,971.0	114,017.5	6.21	19715.00	2.0200	17895.80	3075.20	9456880.04
22,724.8	127,746.9	14.30	22933.20	2.0900	20794.23	1930.57	3727089.02
21,025.9	139,386.5	11.24	28314.50	2.3300	21132.02	-106.12	11260.79
24,162.1	160,646.5	12.98	35497.90	2.6700	23236.82	925.28	856147.60
32,193.0	186,689.9	18.08	41853.00	2.6700	26758.67	5434.33	29531923.31
29,821.5	243,412.9	35.60	58663.30	3.3000	35233.92	-5412.42	29294335.27
40,768.0	342,803.3	36.50	66445.70	5.7500	41176.69	-408.69	167024.93
55,652.6	471,295.4	36.91	77739.00	5.8300	52186.34	3466.26	12014966.60
61,476.1	582,936.7	16.91	93642.90	6.0107	57730.19	3745.91	14031806.17
62,195.0	693,514.6	17.75	120800.00	6.1815	68168.29	-5973.29	35680178.49
86,106.0	823,939.0	32.35	203368.00	6.6751	85814.45	291.55	85002.12
116,090.0	1,176,630.0	72.94	430786.00	24.3527	115912.95	177.05	31347.75
$\sum e_{2i}^2$							**167677665.48**

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We conclude that:

$\sum e_{2i}^2 =$ 167677665.48……………………………… (4-2)

As the d.f of error for each group will be $\left[\frac{n-c}{2} - k - 1\right]$ so, after compute for each group it will be $d.f = 11$

Now we calculate the value of the F-test:

Hence:

From equations (4-1) and (4-2) according to the data of Table (4 - 13), we get:

$\partial_{u1}^2 = 1735.05$, $\partial_{u2}^2 = 15243424.13$

$$\therefore F = \frac{15243424.13}{1735.05} = \quad 8,785.59$$

By comparing the calculated value of F to the tabular at two d.f $\left[\frac{n-c}{2} - k - 1\right]$ for the numerator and the same for denominator in significance level $\frac{\alpha}{2}$ i.e. $F_{11,11,0.025}$ where it was value in F-Table $F_{8,8,0.025} = 3.4737$.

By comparison, the calculated value was found to be greater than the tabulated value, so we reject the null hypothesis; meaning that the model suffers from Heterocedasticity according to the Gold-Field Quandt Test

4.7. Comparison between Detection Methods for Heterocedasticity of the Actual Model:

Table (4 - 14): Comparison between Detection Methods of Heterocedasticity for the Actual Model

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	decision
Breuch-Pagan Godfry	3.025813	2532135	37.043	0.25	0.0349	Heterocedasticity
Harvey	4.050957	1.800265	4.1251	0.30	0.0123	Heterocedasticity
Glejser	3.993695	2199.609	18.341	0.30	0.0130	Heterocedasticity
ARCH LM Test	0.330196	2824288	37.198	0.01	0.5688	Homogeneous
White	4.427186	1881024	36.61	0.70	0.0096	Heterocedasticity
Park	8.66455	0.379331	0.3842	0.49	0.0014 0.0000 0.0506 0.0027	Heterocedasticity
Spearman's Rank Correlation Coefficient	3.822 -3.912 3.117 3.23	-	-	-	-	Heterocedasticity
Gold-Field Quandt	8785.59	-	-	-	-	Heterocedasticity

Source: Researcher preparation 2020, using Excel, 9 EViews, and SPSS V.20

4.8. Remedies of Heterocedasticity for the Actual Model:

4.8.1. Applying First Assumption for the Actual Model: $\sigma_{ui}^2 = \sigma_u^2 X_i^2$

Accordingly, the model data will be divided by the variable of higher relative importance as follows:

Applied in: $\hat{\beta}_j^* = \hat{\beta}_j \frac{S_{x_j}}{S_y}$

We will get:

Table (4 - 15) the relative importance of the variables for the actual model

Estimates	GDP	INF	MS	EXCH_Of
S_{x_j}	255024.3	41.9	74942.59	4.008966
$\hat{\beta}_j$	0.107	-27.66	-0.397	349.06
$S_y = S_{EXPE}$	26183.53			
$\hat{\beta}_j^*$	1.0438	-0.044	-0.114	0.0534

Source: Researcher preparation 2020, using Excel, 9 EViews, and SPSS V.20

From Table (4 - 15) we note that the highest value of $\hat{\beta}_j^*$ is (1.0438) according to it the most importance variable will be (GDP) variable, and according to the first assumption we divide all variables by (GDP).

So the equation of the model after applied becomes as follows (see 2.7.1):

$$\hat{EXPE} = 0.118 - 0.524\,GDP + 0.005\,INF - 0.029\,MS - 177.783\,EXCH$$

Whereas, the value of the coefficient of determination of the model is $R^2 = 0.48$

4.8.1.1. Significance Test of the First Remedy for the Actual Model:

We will test the following hypotheses:

H_o : The Model of First Remedy is Significance

Against

H_1 : The Model of First Remedy is No Significance

We form the ANOVA analysis table as follows:

Table (4 - 16): ANOVA Table for the first remedy of actual model

Model	d.f	Mean Square	Mean Square	F	Sig.
Regression	4	0.069	0.17	8.625	0.000
Residual	37	0.073	0.02		
Total	41	0.142	-		

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 16) we note the following:
- F-test value equal to (8.625)
- The Significance value is equal to (0.000) and it is less than (0.05), so we reject the null hypothesis and accept the alternative hypothesis, which is that the model is Significance.

4.8.1.2. Detection of Heterocedasticity for the First Remedy Model for the Actual Model:

By applied for all detection methods like we did in the original data as before (see: 4.7), we get the table below:

Table (4 - 17): Comparison between Detection Methods of Heterocedasticity for First Remedy of the Actual Model

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	decision
Breuch-Pagan Godfry	4.088	0.0027	-8.868	0.31	0.0119	Heterocedasticity
Harvey	3.521	2.3474	4.656	0.28	0.0208	Heterocedasticity
Glejser	4.804	0.0265	-4.311	0.34	0.0062	Heterocedasticity
ARCH LM Test	31.216	0.0024	-9.215	0.44	0.0000	Heterocedasticity
White	2.917	0.0024	-8.948	0.60	0.0319	Heterocedasticity
Park	4.263	2.1756	4.506	0.32	0.3554 0.5846 0.0015 0.0067	Heterocedasticity
Spearman's Rank Correlation Coefficient	-1.372 -0.735 -2.37 -0.079	-	-	-	-	Heterocedasticity
Gold-Field Quandt	3.0306	-	-	-	-	Homogeneous

Source: Researcher preparation 2020, using Excel, 9 EViews, and SPSS V.20

4.8.2. Applying Second Assumption for the Actual Model: $\sigma_{ui}^2 = \sigma_u^2 X_i$

From Table (4 - 15) we note that the highest value of $\hat{\beta}_j^*$ is (1.0438) according to it the most importance variable will be (GDP) variable, and according to the second assumption we divide all variables by $\sqrt{GDP}$.

So the equation of the model after applied becomes as follows (see 2.7.2):

$$\left(\frac{EX\hat{P}E}{\sqrt{GDP}}\right) = 3.804 + 0.11698\left(\frac{GDP}{\sqrt{GDP}}\right) - 1.0408\left(\frac{INF}{\sqrt{GDP}}\right) - 0.031\left(\frac{MS}{\sqrt{GDP}}\right) - 148.176\left(\frac{EXCH\_OF}{\sqrt{GDP}}\right)$$

Whereas, the value of the coefficient of determination of the model is $R^2 = 0.90$

4.8.2.1. Significance Test for the Second Remedy of the Actual Model:

We will test the following hypotheses:

H_o : The Model of Second Remedy is Significance

Against

H_1 : The Model of Second Remedy is No Significance

We form the ANOVA analysis table as follows:

Table (4 - 18): ANOVA Table for the second remedy of the Actual Model

Model	d.f	Mean Square	Mean Square	F	Sig.
Regression	4	40260.066	10065.02	83.256	0.000
Residual	37	4473.008	120.892		
Total	41	44733.074	-		

Source: Researcher preparation 2020 using EViews 9

From Table (5 - 18) we note the following:

- F-test value equal to (83.256)
- The Significance value is equal to (0.000) and it is less than (0.05), so we reject the null hypothesis and accept the alternative hypothesis, which is that the model is Significance.

5.8.2.2. Detection of Heterocedasticity of the Second Remedy Model for the Model:

By applied for all detection methods like we did in the original data as before (see: 4.7), we get the table below:

Table (4 - 19): Comparison between Detection Methods of Heterocedasticity for Second Remedy of the Actual Model

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	decision
Breuch-Pagan Godfry	3.394	157.212	13.064	0.27	0.024	Heterocedasticity
Harvey	4.748	2.624	4.879	0.34	0.007	Heterocedasticity
Glejser	4.201	6.447	6.676	0.31	0.011	Heterocedasticity
ARCH LM Test	6.473	165.027	13.098	0.14	0.016	Heterocedasticity

White	5.943	106.506	12.447	0.75	0.004	Heterocedasticity
Park	14.958	2.005	4.343	0.62	0.000 0.914 0.03 0.318	Heterocedasticity
Spearman's Rank Correlation Coefficient	4.935 -5.026 0.519 2.758	-	-	-	-	Heterocedasticity
Gold-Field Quandt	7.736	-	-	-	-	Heterocedasticity

Source: Researcher preparation 2020, using Excel, 9 EViews, and SPSS V.20

4.8.3. Applying Third Assumption for the Actual Model: $\sigma_{ui}^2 = \sigma_u^2 \left[E\left(\hat{Y}_i\right) \right]^2$

Divided original data by $\hat{y}$ (See 2.7.3)

So the equation of the model after applied becomes as follows (see 2.7.3):

$$\left(\frac{EX\hat{P}E}{\hat{y}}\right) = 0.06 + 0.089\left(\frac{GDP}{\hat{y}}\right) - 4.178\left(\frac{INF}{\hat{y}}\right) + 0.103\left(\frac{MS}{\hat{y}}\right) + 179.874\left(\frac{EXCH\_OF}{\hat{y}}\right)$$

Whereas, the value of the coefficient of determination of the model is $R^2 = 0.749$

4.8.3.1. Significance Test of the Third Remedy for the Actual Model:

We will test the following hypotheses:

H_o : The Model of Third Remedy is Significance

Against

H_1 : The Model of Third Remedy is No Significance

We form the ANOVA analysis table as follows:

Table (4 - 20): ANOVA Table for the third remedy of the Actual Model

Model	d.f	Mean Square	Mean Square	F	Sig.
Regression	4	9.545	2.386	27.572	0.000
Residual	37	3.202	0.087		
Total	41	12.748	-		

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 20) we note the following:

- F-test value equal to (27.572)

- The Significance value is equal to (0.000) and it is less than (0.05), so we reject the null hypothesis and accept the alternative hypothesis, which is that the model is Significance.

4.8.3.2. Detection of Heterocedasticity of the Third Remedy Model for the Actual Model:

By applied for all detection methods like we did in the original data as before (see: 4.7), we get the table below:

Table (4 - 21): Comparison between Detection Methods of Heterocedasticity for the third Remedy

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	decision
Breuch-Pagan Godfry	5.308	0.108	-1.495	0.36	0.0041	Heterocedasticity
Harvey	2.696	2.773	4.989	0.23	0.0502	Homogeneous
Glejser	3.688	0.178	-0.504	0.28	0.0176	Heterocedasticity
ARCH LM Test	6.973	0.121	-1.331	0.15	0.0126	Heterocedasticity
White	8.013	0.07	-2.205	0.80	0.0022	Heterocedasticity
Park	5.07	2.6	4.871	0.38	0.038 0.926 0.108 0.339	Heterocedasticity
Spearman's Rank Correlation Coefficient	2.438 -1.969 0.999 2.288	-	-	-	-	Heterocedasticity
Gold-Field Quandt	105.06	-	-	-	-	Heterocedasticity

Source: Researcher preparation 2020, using Excel, 9 EViews, and SPSS V.20

4.8.4. Applying Fourth Assumption for the Actual Model: $\sigma_{ui}^2 = \sigma_u^2 |e_i|$

Divided original data by $\sqrt{|e_i|}$

So the equation of the model after applied becomes as follows (see 4.7.4):

$$\left(\frac{\hat{EXPE}}{\sqrt{|e_i|}}\right) = 24.32 + 0.113\left(\frac{GDP}{\sqrt{|e_i|}}\right) - 8.298\left(\frac{INF}{\sqrt{|e_i|}}\right) - 0.063\left(\frac{MS}{\sqrt{|e_i|}}\right) + 424.708\left(\frac{EXCH\_OF}{\sqrt{|e_i|}}\right)$$

Whereas, the value of the coefficient of determination of the model is $R^2 = 0.749$

4.8.4.1. Significance Test of the Fourth Remedy for the Actual Model:

We will test the following hypotheses:

H_o : The Model of Fourth Remedy is Significance

Against

H_1 : The Model of Fourth Remedy is No Significance

We form the ANOVA analysis table as follows:

Table (4 - 22): ANOVA Table of the fourth remedy for the Actual Model

Model	d.f	Mean Square	Mean Square	F	Sig.
Regression	4	13572423.86	3393106	1225.36	0.000
Residual	37	102455.83	2769.08		
Total	41	13674879.69	-		

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 22) we note the following:

- F-test value equal to (1225.36)
- The Significance value is equal to (0.000) and it is less than (0.05), so we reject the null hypothesis and accept the alternative hypothesis, which is that the model is Significance.

4.8.4.2. Detection of Heterocedasticity of the Fourth Remedy for the Actual Model:

By applied for all detection methods like we did in the original data as before (see: 4.6), we get the table below:

Table (4 - 23): Comparison between Detection Methods of Heterocedasticity for the fourth Remedy of the actual model

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	Decision
Breuch-Pagan Godfry	1.87	3147.44	19.06	0.17	0.132	Homogeneous
Harvey	5.57	1.815	4.14	0.38	0.0033	Heterocedasticity
Glejser	4.02	25.96	9.46	0.3	0.0126	Heterocedasticity
ARCH LM Test	4.95	3152.19	19	0.11	0.0317	Heterocedasticity
White	6.99	1879.25	18.19	0.78	0.0030	Heterocedasticity
Park	12.17	1.52	3.79	0.57	0.249 0.000 0.458 0.682	Heterocedasticity

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	Decision
Spearman's Rank Correlation Coefficient	4.264	-	-	-	-	Heterocedasticity
	-5.301					
	3.54					
	3.014					
Gold-Field Quandt	2155.86	-	-	-	-	Heterocedasticity

Source: Researcher preparation 2020, using Excel, 9 EViews, and SPSS V.20

4.8.5. Applying Fifth Assumption for the Actual Model:

$\log Y_i = \beta_o + \beta_1 \log X_i + U_i$

By taking the logarithm for all variables in original data

So the equation of the model after applied becomes as follows (see 2.7.5):

$$\mathrm{Log}\left(\mathrm{E\hat{X}PE}\right) = 0.241327 + 0.530\left(\mathrm{Log}\left(\mathrm{GDP}\right)\right) - 0.264\left(\mathrm{Log}\left(\mathrm{INF}\right)\right) + 0.304\left(\mathrm{Log}\left(\mathrm{MS}\right)\right) + 0.445\left(\mathrm{Log}\left(\mathrm{EXCH\_OF}\right)\right)$$

Whereas, the value of the coefficient of determination of the model is $R^2 = 0.990$

4.8.5.1. Significance Test for the Fifth Remedy of the Actual Model:

We will test the following hypotheses:

H_o : The Model of Fifth Remedy is Significance

Against

H_1 : The Model of Fifth Remedy is No Significance

We form the ANOVA analysis table as follows:

Table (4 - 24): ANOVA Table for the fifth remedy of the Actual Model

Model	d.f	Mean Square	Mean Square	F	Sig.
Regression	4	133.484	33.371	934.365	0.000
Residual	37	1.321	0.036		
Total	41	134.805	-		

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 22) we note the following:

- F-test value equal to (934.365)
- The Significance value is equal to (0.000) and it is less than (0.05), so we reject the null hypothesis and accept the alternative hypothesis, which is that the model is Significance.

4.8.5.2. Detection of Heterocedasticity for the Fifth Remedy of the Actual Model:

By applied for all detection methods like we did in the original data as before (see: 4.6), we get the table below:

Table (4 - 25): Comparison between Detection of Heterocedasticity for the Fifth Remedy of the Actual Model

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	Decision
Breuch-Pagan Godfry	2.35	0.048	-3.12	0.21	0.075	Homogeneous
Harvey	0.34	1.49	3.75	0.04	0.83	Homogeneous
Glejser	1.07	0.1	-1.64	0.11	0.36	Homogeneous
ARCH LM Test	0.12	0.05	-3.02	.003	0.72	Homogeneous
White	5.18	0.03	-3.73	0.73	0.00	Heterocedasticity
Park	0.56	2.29	4.68	0.11	0.43 0.67 0.33 0.816	Homogeneous
Spearman's Rank Correlation Coefficient	-0.779 -0.624 -0.642 -1.346	-	-	-	-	Homogeneous
Gold-Field Quandt	1.03	-	-	-	-	Homogeneous

Source: Researcher preparation 2020, using Excel, 9 EViews, and SPSS V.20

4.8.6. Applying Sixth Assumption for the Actual Model (general case):

In all of the previous cases (see 2.7.6):

$$\sigma_{ui}^2 = \sigma_u^2 f\left(X_i\right)$$

The Researcher suggested: $\sigma_{ui}^2 = \sigma_u^2 \left[E(\hat{y})\right]$

According to it we will divided all original variables by $\sqrt{\hat{y}}$

So the equation of the model after applied becomes as follows:

$$\left(\frac{EX\hat{P}E}{\sqrt{\hat{y}}}\right) = 17.728 + 0.107\left(\frac{GDP}{\sqrt{\hat{y}}}\right) - 8.932\left(\frac{INF}{\sqrt{\hat{y}}}\right) - 0.008\left(\frac{MS}{\sqrt{\hat{y}}}\right) - 59.806\left(\frac{EXCH\_OF}{\sqrt{\hat{y}}}\right)$$

Whereas, the value of the coefficient of determination of the model is $R^2 = 0.92$

4.8.6.1. Significance Test for the sixth Remedy of the Actual Model:

We will test the following hypotheses:

H_o : The Model of Sixth Remedy is Significance

Against

H_1 : The Model of Sixth Remedy is No Significance

We form the ANOVA analysis table as follows:

Table (4 - 26): ANOVA Table for the sixth remedy of the Actual Model

Model	d.f	Mean Square	Mean Square	F	Sig.
Regression	4	383035.66	95758.9	105.897	0.000
Residual	37	33457.82	904.265		
Total	41	416493.48	-		

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 26) we note the following:

- F-test value equal to (105.897)
- The Significance value is equal to (0.000) and it is less than (0.05), so we reject the null hypothesis and accept the alternative hypothesis, which is that the model is Significance.

4.8.6.2. Detection of Heterocedasticity for the Sixth Remedy of the Actual Model:

By applied for all detection methods like we did in the original data as before (see: 4.6), we get the table below:

Table (4 - 27): Comparison between Detection Methods of Heterocedasticity for the sixth Remedy of the Actual Model

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	decision
Breuch-Pagan Godfry	1.82	1230.28	17.18	0.16	0.141	Homogeneous
Harvey	0.92	2.58	4.85	0.09	0.435	Homogeneous
Glejser	2.24	17.1	8.63	0.19	0.08	Homogeneous
ARCH LM Test	3.47	1253.03	17.15	0.08	0.06	Homogeneous
White	5.22	818.15	16.52	0.73	0.00	Heterocedasticity

<table>
<tr><th>Test</th><th>Test Value</th><th>S.E. of regression</th><th>AIC</th><th>R^2</th><th>Prob-Value</th><th>decision</th></tr>
<tr><td rowspan="4">Park</td><td rowspan="4">0.8</td><td rowspan="4">2.63</td><td rowspan="4">4.88</td><td rowspan="4">0.08</td><td>0.25</td><td rowspan="4">Homogeneous</td></tr>
<tr><td>0.31</td></tr>
<tr><td>0.52</td></tr>
<tr><td>0.30</td></tr>
<tr><td rowspan="4">Spearman's Rank Correlation Coefficient</td><td>3.248</td><td rowspan="4">-</td><td rowspan="4">-</td><td rowspan="4">-</td><td rowspan="4">-</td><td rowspan="4">Heterocedasticity</td></tr>
<tr><td>-3.635</td></tr>
<tr><td>2.295</td></tr>
<tr><td>1.491</td></tr>
<tr><td>Gold-Field Quandt</td><td>422.708</td><td>-</td><td>-</td><td>-</td><td>-</td><td>Heterocedasticity</td></tr>
</table>

Source: Researcher preparation 2020, using Excel, 9 EViews, and SPSS V.20

4.9. Comparison of Detections Methods of Heterocedasticity for the Actual Model:

Table (4 - 28) Comparison of Detections Methods of Heterocedasticity for the Actual Model

Table Number in Comparisons Between Detection Methods for the actual model	Maximum R^2	Minimum AIC	Minimum P.value
(4 - 14)	White Test	Harvey Test	White Test
(4 – 17)	White Test	Glejser Test	ARCH LM TEST
(4 – 19)	White Test	Park Test	White Test
(4 – 21)	White Test	Glejser Test	White Test
(4 – 23)	White Test	Park Test	White Test
(4 – 25)	White Test	Glejser Test	White Test
(4 – 27)	White Test	Harvey Test	White Test

Source: Researcher preparation 2020

We conclude from Table (4 - 28) that the best test that led to the detection of Heterocedasticity of the actual model was White test, as it proved its best in helping to detect the problem when it was applied in the original model and the remedies, According to AIC the best test is Glejser Test (The Akaike information criterion (AIC) is an estimator of out-of-sample prediction error and thereby relative quality of statistical models for a given set of data (Wikipedia, 2020))

4.10. Comparison of Remedies of Heterocedasticity for the Actual Model:

Table (4 - 29) Comparisons of Remedies of Heterocedasticity for the original Model

Remedy	ratio of remedy to test
First	1 : 8
Second	0 : 8
Third	1 : 8
Fourth	1 : 8
Fifth	7 : 8
Sixth	5 : 8

Source: Researcher preparation 2020

From Table (4 - 29) we note that the best remedy led to remedy Heterocedasticity in the actual model is fifth remedy according to logarithm assumption $\log Y_i = \beta_o + \beta_1 \log X_i + U_i$, because it was proved that 7 out of the 8 detection methods led to the remedy, followed by the remedy (suggested by the researcher) based on the general case where it is proven, 5 out of the 8 methods of detection led to the remedy of the problem.

Secondary: For Simulated Model:

4.11. Sufficiency Test for Simulated Data:

Hypothesis of the sufficiency was tested by Kaiser-Meyer-Olkin (K M O) test, which values fall between 0 – 1. KMO measures the sampling adequacy which should be greater than 0.5

So by applying it to the study data, we get:

Table (4 - 30) Test value (K M O) for simulated data

Test	value	d.f	Sig. value
K M O	0.516	10	0.000

Source: Researcher preparation 2020 using SPSS V. 20

From Table (4 - 30) we note that the test value is (0.516) and it falls within the range (0.5 - 1). Therefore, the data is sufficient for the test, and what confirms that it is the significance of the probability value which is equal to (0.000) which is less than 0.05.

4.12. Estimation of MLR of the simulated model and its significance test:

Firstly: estimate MLR model for simulated model:

Table (4 - 31): estimate MLR for simulated model:

Model	**Coefficient**	**St.Error**	**t-Statistic**	**Prob.**	R^2
GDP_s	0.103728	0.001012	102.4695	0.0000	0.997
INF_s	1.347000	6.955119	0.193670	0.8475	
MS_s	0.039919	0.027453	1.454062	0.1544	
EXCH_s	-619.8979	443.8631	-1.396597	0.1709	
C	357.8441	549.9865	0.650642	0.5193	

Source: Researcher preparation 2020 using EViews 9

According to Table (4 - 31), the estimated model equation will be as follows:

$$\widehat{EXPE}\_s = 357.844 + 0.104GDP\_s + 1.347INF\_s + 0.0399MS\_s - 619.898EXCH\_s$$

Interpretation of the model parameters:

$\hat{\beta}_o$: Its value (357.8441) is interpreted as the average dependent variable EXPE_s (expenditures) when the value of the independent variables (GDPS_s, INF_s, MS_s and EXCH_s) is equal to zero, that is, without taking into account the effect of the other independent variables.

$\hat{\beta}_1$: If the independent simulated variable GDP_s (gross domestic product) increases by one unit, then the EXPE_s simulated variable (expenditures) increases by (0.103728) million SDG with the stability of the rest of the other independent variables. Thus the relationship between GDP_s and EXPE_s is a direct relationship.

$\hat{\beta}_2$: If the independent simulated variable INF_s (inflation) increases by 1%, then the EXPE_s simulated variable (expenditures) increases by (1.35) %, with stability of the rest of the other independent variables, indicating an direct relationship between INF and EXPE.

$\hat{\beta}_3$: Likewise, if the simulated independent variable MS_s (money supply) increases by one unit, then the EXPE_s variable (expenditures)) increases by (0.03992) unit with the stability of the rest of the other independent variables, and the relationship between MS and EXPE also is a direct relationship

$\hat{\beta}_4$: If the simulated independent variable EXCH_s (the exchange rate) increases by one unit, then the EXPE variable (expenses) decreases by an amount of (619.898) unit with the rest of the other independent variables' stability; meaning that the relationship between EXCH_s and EXPE is inverse relationship.

• The value of the coefficient of determination (R^2) equals (0.997), which is a very large percentage that explains that the percentage of the simulated independent variables (GDP_s, INF_s, MS_s, EXCH_s) in causing changes in the simulated dependent variable (EXPE_s) is 99.7%, while 0.03 is due to measurement errors.

Secondly: Test of Significance for simulated Model:

We will test the following hypotheses:

H_o: The Model is Significance

Against

H_1: The Model is No Significance

We form the ANOVA analysis table as follows:

Table (4 - 32): table of Analysis of variance for the estimated simulated model (ANOVA)

Model	d.f	Sum of Squares	Mean Square	F	Sig.
Regression	4	2.351E10	5.877E9	3.022E3	0.000
Residual	37	7.196E7	1944776.004		
Total	41	2.358E10			

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 32) we note the following:

- F-test value equal to (3.022E3)
- The significance value is equal to (0.000) and since it is less than (0.05), we reject the null hypothesis and accept the alternative hypothesis, which is that the simulated model is significant, i.e. the significance of the effect of the independent variables on the dependent variable

4.13. Detection of Heterocedasticity for the Simulated Model:

The hypothesis to be tested here is:

H_o: U_i'*s are* hom*oscedastic*

Against

H_1: U_i'*s are heteroscerdastic*

4.13.1. Breusch - Pagan - Godfrey Test for the Simulated Model:

Table (4 - 33): Breusch - Pagan - Godfrey test results for the Simulated Model

Test	F-statistic	Prob-Value	S.E. of regression	Akaike info criterion	R^2
Breuch - Pagan godfrey	1.384	0.2427	1650019	31.58182	0.13

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 33) it becomes clear that the test value is (1.384) and the probability value is equal to (0.2427) and it is greater than the level of significance (0.05). Therefore, we Accept the null hypothesis; meaning that residuals are homogeneous according to the Breuch - Pagan Godfrey test, which indicates that the test isn’t helped in detection of the problem of Heterocedasticity with a determination coefficient (0.13%).

4.13.2. Harvey Test for the Simulated Model:

Table (4 - 34): Harvey test results for the simulated Model

Test	F-statistic	Prob-Value	S.E. of regression	Akaike info criterion	R^2
Harvey	14.65	0.0000	1.372	3.58	0.61

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 34) it becomes clear that the test value is (14.65) and the probability value is equal to (0.0000) and it is less than the level of significance (0.05). Therefore, we reject the null hypothesis, meaning that the residuals are not homogeneous, which indicates that the test helped in detection of the problem of Heterocedasticity with a determination coefficient (0.61%).

4.13.3. Glejser Test for the Simulated Model:

Table (4 - 35): Glejser Test results for the simulated Model

Test	F-statistic	Prob-Value	S.E. of regression	Akaike info criterion	R^2
Glejser	4.9046	0.006	554.3699	15.585	0.35

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 35) it becomes clear that the test value is (4.905) and the probability value is equal to (0.006), which is less than the level of significance (0.05). Therefore, we reject the null hypothesis; meaning that the residuals are not homogeneous, so there is a problem of Heterocedasticity according to the Glejser test, which indicates however that the test assisted in detection with a determination coefficient (0.35).

4.13.4. ARCH LM Test for the Simulated Model:

Table (4 - 36): ARCH LM test results of the simulated Model

Test	**F-statistic**	**Prob-Value**	**S.E. of regression**	**Akaike info criterion**	R^2
ARCH LM	0.000722	0.978	1714020	31.59	0.000019

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 36) we note that the test value is (0.000722) and the probability value is equal to (0.978), which is greater than the level of significance (0.05). Therefore, we accept the null hypothesis that means residuals are homogeneous, so there is no problem of Heterocedasticity according to the ARCH LM test with Coefficient of determination value (0.000019%).

4.13.5. White Test for the Simulated Model:

Table (4 - 37): White test results of the simulated Model

Test	**F-statistic**	**Prob-Value**	**S.E. of regression**	**Akaike info criterion**	R^2
White	1.316	0.254	1596561	31.677	0.41

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 37) it becomes clear that the test value is (1.316) and the probability value is equal to (0.254), which is greater than the level of significance (0.05). Therefore, we accept the null hypothesis; meaning that residuals are homogeneous, so there is no Problem of Heterocedasticity according to White's test, with a Coefficient of determination (0.41%).

4.13.6. Park Test for the Simulated Model:

There is no software package that performs the testing by direct command, but the test can be performed indirectly with SPSS or EViews by the method of transfer functions (see the theoretical side) and here we used EViews and the result is as follows:

Table (4 - 38): Park test results

Test	F-statistic	Prob-Value	S.E. of regression	Akaike info criterion	R^2
Park	2.477	0.1176	1.958	4.293	0.21
		0.1715			
		0.0277			
		0.0368			

Source: Researcher preparation 2020 using EViews

From Table (4 - 38) it becomes clear that the test value is (2.477) and the probability values are equal to (0.1176, 0.1715, 0.0277, 0.0368) respectively, and two of them are less than the level of significance (0.05) and the rest of the values (0.0277) and (0.0368), hence we reject the null hypothesis; meaning that the Residuals are Heterocedasticity according to the Park test, which means that the Park test helped in the detection of the problem with a Coefficient of determination (0.21)

4.13.7. Spearman's Rank Correlation Coefficient Test for the Simulated Model:

After estimating the model and calculating the absolute value of errors, we calculate the coefficient of ranks correlation for each independent variable with the absolute value of the error term, and accordingly there will be 4 parameters as follows (look 2.6.7):

Table (4 - 39) results of the ranks correlation coefficient test

variable	GDP_s	INF_s	MS_s	EXCH_s
Correlation Coefficients	-0.359	-0.289	-0.027	-0.027
t test value for r_s	-2.344	-1.840	-0.166	-0.166

Source: Researcher preparation 2020

Compare to:

$$t_{n-k-1,\frac{\alpha}{2}} = t_{37,0.025} = 2.026$$

From Table (11) we notice that there is one value (2.344) greater than the tabulated value, and therefore we reject the null hypothesis; meaning that the model suffers from the problem of Heterocedasticity according to Spearman's rank correlation test.

4.13.8. The Gold-Field Quandt Test for the Simulated Model:

We apply the steps as mentioned in (2.6.8)

$$C = \frac{n}{4} = \frac{42}{4}$$

First: Group One:

The estimated model will be as follows:

$$EX\hat{P}E1\_s = -707.525 + 0.101GDP\_s + 26.67INF\_s + 0.247MS\_s - 3171.493EXCH\_s$$

Accordingly, the estimators will be as shown in Table (4 - 40)

Table (4 - 40): Estimates of the First Group of the Gold-Field Quandt Test

EXPE_s	GDP_s	INF_s	MS_s	EXCH_s	e	e^2
25805.788	236547.533	76.739	1928.786	0.090	334.720	112037.259
39431.599	398856.282	26.051	2250.267	0.162	-964.393	930053.242
18247.710	162932.814	49.415	3055.576	0.166	917.590	841970.655
5961.205	72858.926	31.705	4516.584	0.169	-2130.177	4537654.627
31714.256	294095.255	32.372	4615.394	0.236	1400.910	1962549.121
6844.776	51869.701	37.292	9363.412	0.317	-0.827	0.684
91012.217	871649.822	94.746	10191.576	0.517	97.080	9424.617
10088.779	83465.877	16.604	10531.843	0.805	1857.457	3450146.678
82543.083	789161.535	137.133	11082.682	1.010	188.524	35541.275
30952.106	316267.100	62.722	12506.350	1.037	-1822.605	3321888.249
3881.190	52599.845	33.578	12743.376	1.373	-423.831	179632.814
2513.287	9681.549	65.536	18925.755	1.533	680.977	463729.697
28615.577	263914.514	51.031	24590.779	1.658	435.723	189854.308
6495.726	48469.994	52.534	27852.997	1.766	-384.421	147779.351
2772.322	12204.511	44.511	29281.117	1.880	-214.233	45895.754
35747.329	333376.869	66.688	29642.365	2.022	27.506	756.592
$\sum e_{1i}^2$						**16228914.924**

Preparing the Researcher 2020 manually and with the help of Excel and 9 EViews

We conclude that:

$\sum e_{1i}^2$ = 16228914.924……………………………… (4-3)

Second: The Second Group:

The estimated model will be as follows:

$$E\hat{X}PE_2\_s = -952.297 + 0.104GDP\_s + 12.4\,INF\_s + 0.3MS\_s - 349.212EXCH\_s$$

Accordingly, the estimates will be as shown in Table (4 - 41)

Table (4 - 41): Estimates of the Second group of the Gold-Field Quandt Test

EXPE_s	**GDP_s**	**INF_s**	**MS_s**	**EXCH_s**	e	e^2
42587.4	429593.3982	3.9720	65121.633	3.974256682	-1650.965115	2725685.811
28094.14	258835.8268	87.0260	66819.326	4.055494149	524.1963918	274781.8572
3244.43	16802.78563	57.7492	69276.894	4.40865858	1204.961504	1451932.226
14247.38	123970.1214	75.0587	74878.274	4.597993145	770.3369214	593418.9725
7159.991	84534.94725	34.1068	74920.129	5.772134529	-1307.945715	1710721.993
36033.63	336165.4068	21.6592	81332.675	5.836292794	1437.163752	2065439.651
8897.763	71865.52646	84.0897	84870.962	5.841752878	851.5547329	725145.4631
7308.054	85977.05423	99.8592	88348.821	6.265916632	-2354.039642	5541502.634
63673.87	605377.8445	59.2111	92485.956	6.445060256	552.646224	305417.8489
14092.98	122466.2596	29.2037	92873.615	6.511474566	1470.799852	2163252.206
16046.64	171089.7789	8.3377	101469.941	6.583440114	-1594.700402	2543069.372
12509.88	136642.1516	43.4973	107042.523	7.590710042	-1807.472199	3266955.75
8401.126	67028.35058	34.3402	109974.485	8.038146865	1490.260042	2220874.993
31963.5	296522.8311	16.8895	140325.680	8.670532152	766.0153457	586779.5098
21569.2	195283.6741	83.1968	159864.395	8.678189031	-525.7796358	276444.2254
5812.032	41810.90373	36.7165	164124.729	8.906929177	172.9679416	29917.90883
$\sum e_{2i}^2$						**26481340.42**

Preparing the Researcher 2020 manually and with the help of Excel and 9 EViews

We conclude that:

$\sum e_{2i}^2 = 26481340.42$……………………………… (4-4)

As the d.f of error for each group will be $\left[\frac{n-c}{2} - k - 1\right]$ so, after compute for each group it will be $d.f = 11$

Now we calculate the value of the F-test:

Hence:

From equations (4-3) and (4-4) according to the data of Table (4 - 41), we get:

$\partial_{u1}^2 = 1475355.902$, $\partial_{u2}^2 = 2407394.584$

$$\therefore F = \frac{2407394.584}{1475355.902} = 1.632$$

By comparing the calculated value of F to the tabular at two d.f $\left[\frac{n-c}{2} - k - 1\right]$ for the numerator and the same for denominator in significance level $\frac{\alpha}{2}$ i.e. $F_{11,11,0.025}$ where it was value in F-Table $F_{8,8,0.025} = 3.4737$.

By comparison, the calculated value was found to be less than the tabulated value, so we Accept the null hypothesis; meaning that the model Homogeneous according to the Gold-Field Quandt Test

4.14. Comparison between Detection Methods of Heterocedasticity for the Simulated Model:

Table (4 - 42): Comparison between Detection Methods of Heterocedasticity for Simulated Model

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	Decision
Breuch-Pagan Godfry	1.384	1650019	31.582	0.13	0.2427	Homogeneous
Harvey	14.65	1.372	3.58	0.61	0.0000	Heterocedasticity
Glejser	4.9046	554.3699	15.585	0.35	0.006	Heterocedasticity
ARCH LM Test	0.000722	1714020	31.59	0.0002	0.978	Homogeneous
White	1.316	1596561	31.677	0.41	0.254	Homogeneous
Park	2.477	1.958	4.293	0.21	0.1176 0.1715 0.0277 0.0368	Heterocedasticity
Spearman's Rank Correlation Coefficient	-2.344 -1.84 -0.166 -0.166	-	-	-	-	Heterocedasticity
Gold-Field Quandt	1.632	-	-	-	-	Homogeneous

Source: Researcher preparation 2020, using Excel, 9 EViews, and SPSS V.20

4.15. Remedies of Heterocedasticity for the Simulated Model:

4.15.1. Applying First Assumption for the Simulated Model: $\sigma_{ui}^2 = \sigma_u^2 X_i^2$

Accordingly, the model data will be divided by the variable of higher relative importance as follows:

Applied in: $\hat{\beta}_j^* = \hat{\beta}_j \frac{S_{x_j}}{S_y}$

We will get:

Table (4 - 43) the relative importance of the variables

Estimates	GDP_s	INF_s	MS_s	EXCH_s
S_{x_j}	230708.43	33.27003394	43136.94	2.67
$\hat{\beta}_j$	0.104	1.347	0.040	-619.898
$S_y = S_{EXPE}$	23982.04			
$\hat{\beta}_j^*$	1.0005	0.0019	0.0719	-0.0690

Source: Researcher preparation 2020, using Excel, 9 EViews, and SPSS V.20

From Table (4 - 43) we note that the highest value of $\hat{\beta}_j^*$ is (1.0005) according to it the most importance variable will be (GDP) variable, and according to the first assumption we divide all variables by (GDP_s).

So the equation of the model after applied becomes as follows (see 2.7.1):

$$\widehat{EXPE}\_s01 = 0.0948 + 1573.858\widehat{GDP}\_s01 + 2.004\widehat{INF}\_s01 + 0.0281\widehat{MS}\_s01 - 466.5705\widehat{EXCH}\_s01$$

Whereas, the value of the coefficient of determination of the model is $R^2 = 0.998$

4.15.1.1. Significance Test for the First Remedy for the simulated Model:

We will test the following hypotheses:

H_o: The Model of First Remedy is Significance

Against

H_1: The Model of First Remedy is No Significance

We form the ANOVA analysis table as follows:

Table (4 - 44): ANOVA Table for the first remedy

Model	d.f	Mean Square	Mean Square	F	Sig.
Regression	4	4.809	1.202	5.768E3	0.000
Residual	37	0.008	0.000		
Total	41	4.817	-		

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 44) we note the following:
- F-test value equal to (5.768E3)
- The Significance value is equal to (0.000) and it is less than (0.05), so we reject the null hypothesis and accept the alternative hypothesis, which is that the model is Significance.

4.15.1.2. Detection of Heterocedasticity for the First Remedy of the simulated Model:

By applied for all detection methods like we did in the original data as before (see: 4.6), we get the table below:

Table (4 - 45): Comparison between Detection Methods of Heterocedasticity for First Remedy of the simulated Model

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	decision
Breuch-Pagan Godfry	0.333	0.000422	-12.59	0.035	0.8335	Homogeneous
Harvey	1.076	4.0138	5.729	0.104	0.3572	Homogeneous
Glejser	1.071	0.0094	-6.388	0.104	0.3596	Homogeneous
ARCH LM Test	0.560	0.0004	-12.688	0.014	0.4462	Homogeneous
White	5.0215	0.0003	-13.329	0.70	0.0058	Heterocedasticity
Park	1.556	3.924	5.6833	0.144	0.0348	Heterocedasticity
					0.2962	
					0.2822	
					0.4693	
Spearman's Rank Correlation Coefficient	0.024	-	-	-	-	Homogeneous
	-0.605					
	0.630					
	0.866					
Gold-Field Quandt	1.1723	-	-	-	-	Homogeneous

Source: Researcher preparation 2021, using Excel, 9 EViews, and SPSS V.20

4.15.2. Applying Second Assumption for the Simulated Model: $\sigma_{ui}^2 = \sigma_u^2 X_i$

From Table (4 - 43) we note that the highest value of $\hat{\beta}_j^*$ is (1.0005) according to it the most importance simulated variable will be (GDP_s) variable, and according to the second assumption we divide all variables by $\sqrt{GDP\_s}$.

So the equation of the model after applied becomes as follows (see 2.7.2):

$$\left(\frac{EX\hat{P}E\_s}{\sqrt{GDP\_s}}\right) = -7.376 + 0.1094\left(\frac{GD\hat{P}\_s}{\sqrt{GDP\_s}}\right) + 15.33\left(\frac{I\hat{N}F\_s}{\sqrt{GDP\_s}}\right) - 0.0528\left(\frac{\hat{MS}\_s}{\sqrt{GDP\_s}}\right) + 1223.9\left(\frac{EX\hat{C}H\_s}{\sqrt{GDP\_s}}\right)$$

Whereas, the value of the coefficient of determination of the model is $R^2 = 0.93$

4.15.2.1. Significance Test for the Second Remedy of the simulated Model:

We will test the following hypotheses:

H_o : The Model of Second Remedy is Significance

Against

H_1 : The Model of Second Remedy is No Significance

We form the ANOVA analysis table as follows:

Table (4 - 46): ANOVA Table for the second remedy of the simulated Model:

Model	d.f	Sum Square	Mean Square	F	Sig.
Regression	4	17946.689	4486.672	122.810	0.000
Residual	37	1351.738	36.533		
Total	41	19298.427	-		

Source: Researcher preparation 2021 using EViews 9

From Table (4 - 46) we note the following:

- F-test value equal to (122.81)
- The Significance value is equal to (0.000) and it is less than (0.05), so we reject the null hypothesis and accept the alternative hypothesis, which is that the model is Significance.

4.15.2.2. Detection of Heterocedasticity for the Second Remedy of the simulated Model:

By applied for all detection methods like we did in the original data as before (see: 4.7), we get the table below:

Table (4 - 47): Comparison between Detection Methods of Heterocedasticity for Second Remedy of the simulated Model

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	decision
Breuch-Pagan Godfry	4.8385	43.0102	10.472	0.34	0.0061	Heterocedasticity
Harvey	8.4139	2.5053	4.786	0.48	0.0005	Heterocedasticity
Glejser	8.2065	2.9803	5.133	0.47	0.0006	Heterocedasticity
ARCH LM Test	1.306	50.8358	10.742	0.03	0.2491	Homogeneous
White	2.702	40.0984	10.493	0.58	0.013	Heterocedasticity

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	decision
Park	2.5208	3.069	5.192	0.21	0.0073	Heterocedasticity
					0.3638	
					0.8465	
					0.7680	
Spearman's Rank Correlation Coefficient	-4.264	-	-	-	-	Heterocedasticity
	1.685					
	0.798					
	1.011					
Gold-Field Quandt	8.712	-	-	-	-	Heterocedasticity

Source: Researcher preparation 2020, using Excel, 9 EViews, and SPSS V.20

4.15.3. Applying Third Assumption for the Simulated Model: $\sigma_{ui}^2 = \sigma_u^2\left[E\left(\hat{Y}_i\right)\right]^2$

Divided original data by $\hat{y}$ (See 2.7.3)

So the equation of the model after applied becomes as follows (see 3.7.3):

$$\left(\frac{EX\hat{P}E\_s}{\hat{y}}\right) = 4.439 - 0.365\left(\frac{GDP\_s}{\hat{y}}\right) - 4.61\left(\frac{INF\_s}{\hat{y}}\right) - 0.145\left(\frac{MS\_s}{\hat{y}}\right) + 2227.229\left(\frac{EXCH\_s}{\hat{y}}\right)$$

Whereas, the value of the coefficient of determination of the model is $R^2 = 0.971$

4.15.3.1. Significance Test for the Third Remedy of the simulated Model:

We will test the following hypotheses:

H_o : The Model of Third Remedy is Significance

Against

H_1 : The Model of Third Remedy is No Significance

We form the ANOVA analysis table as follows:

Table (4 - 48): ANOVA Table for the third remedy of the simulated Model

Model	d.f	Mean Square	Mean Square	F	Sig.
Regression	4	23.101	5.775	314.749	0.000
Residual	37	0.679	0.018		
Total	41	23.780	-		

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 48) we note the following:

- F-test value equal to (314.749)

- The Significance value is equal to (0.000) and it is less than (0.05), so we reject the null hypothesis and accept the alternative hypothesis, which is that the model is Significance.

4.15.3.2. Detection of Heterocedasticity for the Third Remedy Model of the simulated Model:

By applied for all detection methods like we did in the original data as before (see: 4.6), we get the table below:

Table (4 - 49): Comparison between Detection Methods of Heterocedasticity for the third Remedy of the simulated Model:

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	decision
Breuch-Pagan Godfry	0.4594	0.037	-3.667	0.05	0.7650	Homogeneous
Harvey	2.514	1.975	4.310	0.21	0.058	Homogeneous
Glejser	1.254	0.087	-1.939	0.12	0.305	Homogeneous
ARCH LM Test	0.468	0.036	-3.750	0.01	0.498	Homogeneous
White	4.941	0.023	-4.413	0.72	0.0002	Heterocedasticity
Park	2.865	1.946	4.281	0.24	0.003 0.229 0.924 0.743	Heterocedasticity
Spearman's Rank Correlation Coefficient	2.798 0.012 0.915 1.190	-	-	-	-	Heterocedasticity
Gold-Field Quandt	2.941	-	-	-	-	Homogeneous

Source: Researcher preparation 2020, using Excel, 9 EViews, and SPSS V.20

4.15.4. Applying Fourth Assumption for the Simulated Model: $\sigma_{ui}^2 = \sigma_u^2 |e_i|$

Divided original data by $\sqrt{|e_i|}$

So the equation of the model after applied becomes as follows (see 2.7.4):

$$\left(\frac{\hat{\text{EXPE\_s}}}{\sqrt{|e_i|}}\right) = 5.5441 + 0.104\left(\frac{\text{GDP\_s}}{\sqrt{|e_i|}}\right) + 5.136\left(\frac{\text{INF\_s}}{\sqrt{|e_i|}}\right) + 0.031\left(\frac{\text{MS\_s}}{\sqrt{|e_i|}}\right) - 436.837\left(\frac{\text{EXCH\_s}}{\sqrt{|e_i|}}\right)$$

Whereas, the value of the coefficient of determination of the model is $R^2 = 0.999$

4.15.4.1. Significance Test for the Fourth Remedy of the simulated model:

We will test the following hypotheses:

H_o : The Model of Fourth Remedy is Significance

Against

H_1 : The Model of Fourth Remedy is No Significance

We form the ANOVA analysis table as follows:

Table (4 - 50): ANOVA Table for the fourth remedy of the simulated model

Model	d.f	Mean Square	Mean Square	F	Sig.
Regression	4	4.607E8	1.152E8	8.770E4	0.000
Residual	37	48587.462	1313.175		
Total	41	4.607E8	-		

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 50) we note the following:

- F-test value equal to (8.770E4)
- The Significance value is equal to (0.000) and it is less than (0.05), so we reject the null hypothesis and accept the alternative hypothesis, which is that the model is Significance.

4.15.4.2. Detection of Heterocedasticity for the Fourth Remedy Model of the simulated model:

By applied for all detection methods like we did in the original data as before (see: 4.6), we get the table below:

Table (4 - 51): Comparison between Detection Methods of Heterocedasticity for the fourth Remedy for the simulated model

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	Decision
Breuch-Pagan Godfry	2.446	909.916	16.576	0.21	0.0634	Homogeneous
Harvey	20.623	1.002	2.953	0.69	0.0000	Heterocedasticity
Glejser	5.970	12.317	7.971	0.39	0.0008	Heterocedasticity
ARCH LM Test	0.052	992.175	16.685	0.001	0.8213	Homogeneous
White	1.315	923.548	16.767	0.40	0.2617	Homogeneous

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	Decision
Park	8.008	1.318	3.502	0.46	0.0047	Heterocedasticity
					0.0039	
					0.9448	
					0.8322	
Spearman's Rank Correlation Coefficient	-4.286	-	-	-	-	Heterocedasticity
	-4.622					
	-2.702					
	-2.545					
Gold-Field Quandt	3.026	-	-	-	-	Homogeneous

Source: Researcher preparation 2020, using Excel, 9 EViews, and SPSS V.20

4.15.5. Applying Fifth Assumption for the Simulated Model:

$$\log Y_i = \beta_o + \beta_1 \log X_i + U_i$$

By taking the logarithm for all variables in original data

So the equation of the model after applied becomes as follows (see 2.7.5):

$$\text{Log}\left(\hat{\text{EXPE\_s}}\right) = 2.942 + 0.715\left(\text{Log}\left(\text{GDP\_s}\right)\right) - 0.028\left(\text{Log}\left(\text{INF\_s}\right)\right) - 0.163\left(\text{Log}\left(\text{MS\_s}\right)\right) + 0.139\left(\text{Log}\left(\text{EXCH\_s}\right)\right)$$

Whereas, the value of the coefficient of determination of the model is $R^2 = 0.89$

4.15.5.1. Significance Test for the Fifth Remedy for the simulated model:

We will test the following hypotheses:

H_o : The Model of Fifth Remedy is Significance

Against

H_1 : The Model of Fifth Remedy is No Significance

We form the ANOVA analysis table as follows:

Table (4 - 52): ANOVA Table for the fifth remedy for the simulated model

Model	d.f	Mean Square	Mean Square	F	Sig.
Regression	4	7.644	1.911	78.289	0.000
Residual	37	0.903	0.024		
Total	41	8.547	-		

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 52) we note the following:

- F-test value equal to (78.289)

- The Significance value is equal to (0.000) and it is less than (0.05), so we reject the null hypothesis and accept the alternative hypothesis, which is that the model is Significance.

4.15.5.2. Detection of Heterocedasticity for the Fifth Remedy Model of the simulated model:

By applied for all detection methods like we did in the original data as before (see: 4.6), we get the table below:

Table (4 - 53): Comparison between Detection Methods of Heterocedasticity for the fifth Remedy of the simulated model:

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	decision
Breuch-Pagan Godfry	6.180	0.249	0.167	0.40	0.0007	Heterocedasticity
Harvey	0.338	2.367	4.672	0.03	0.8504	Homogeneous
Glejser	2.463	0.235	0.058	0.21	0.0620	Homogeneous
ARCH LM Test	0.211	0.312	0.554	0.01	0.6488	Homogeneous
White	20.401	0.110	-1.294	0.91	0.0000	Heterocedasticity
Park	0.420	2.446	4.765	0.06	0.8333 0.4176 0.7882 0.5807	Homogeneous
Spearman's Rank Correlation Coefficient	0.298 0.012 0.648 0.648	-	-	-	-	Homogeneous
Gold-Field Quandt	30.054	-	-	-	-	Heterocedasticity

Source: Researcher preparation 2020, using Excel, 9 EViews, and SPSS V.20

4.15.6. Applying Sixth Assumption for the Simulated Model (general case):

In all of the previous cases (see 2.7.6):

$\sigma_{ui}^2 = \sigma_u^2 f\ (X_i)$

The Researcher suggested: $\sigma_{ui}^2 = \sigma_u^2 [E(\hat{y})]$

According to it we will divided all original variables by $\sqrt{\hat{y}}$

So the equation of the model after applied becomes as follows:

$$\left(\frac{E\hat{X}PE\_s}{\sqrt{\hat{y}}}\right) = -\ 0.046821 + 0.101\left(\frac{GDP\_s}{\sqrt{\hat{y}}}\right) + 20.316\left(\frac{INF\_s}{\sqrt{\hat{y}}}\right) + 0.071\left(\frac{MS\_s}{\sqrt{\hat{y}}}\right) - 1022.350\left(\frac{EXCH\_s}{\sqrt{\hat{y}}}\right)$$

Whereas, the value of the coefficient of determination of the model is $R^2 = 0.998$

4.15.6.1. Significance Test for the sixth Remedy of the simulated model:

We will test the following hypotheses:

H_o : The Model of Sixth Remedy is Significance

Against

H_1 : The Model of Sixth Remedy is No Significance

We form the ANOVA analysis table as follows:

Table (4 - 54): ANOVA Table for the sixth remedy of the simulated model

Model	d.f	Mean Square	Mean Square	F	Sig.
Regression	4	3421.342	855.336	4178.07	0.000
Residual	37	7.575	0.205		
Total	41	3428.917	-		

Source: Researcher preparation 2020 using EViews 9

From Table (4 - 54) we note the following:

- F-test value equal to (4178.07)
- The Significance value is equal to (0.000) and it is less than (0.05), so we reject the null hypothesis and accept the alternative hypothesis, which is that the model is Significance.

4.15.6.2. Detection of Heterocedasticity for the Sixth Remedy for the simulated model:

By applied for all detection methods like we did in the original data as before (see: 4.6), we get the table below:

Table (4 - 55): Comparison between Detection Methods of Heterocedasticity for the sixth Remedy for the simulated model:

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	Decision
Breuch-Pagan Godfry	4.657	0.292	0.487	0.33	0.004	Heterocedasticity
Harvey	4.367	1.618	3.912	0.32	0.005	Heterocedasticity
Glejser	5.868	0.231	0.022	0.39	0.001	Heterocedasticity

Test	Test Value	S.E. of regression	AIC	R^2	Prob-Value	Decision
ARCH LM Test	2.276	0.338	0.719	0.05	0.139	Homogeneous
White	3.827	0.243	0.277	0.66	0.001	Heterocedasticity
Park	4.869	1.589	3.876	0.34	0.5845	Heterocedasticity
					0.0906	
					0.0466	
					0.4970	
Spearman's Rank Correlation Coefficient	2.407	-	-	-	-	Heterocedasticity
	1.588					
	-3.520					
	-3.286					
Gold-Field Quandt	4.024	-	-	-	-	Heterocedasticity

Source: Researcher preparation 2020, using Excel, 9 EViews, and SPSS V.20

4.16. Comparison of Detections Methods of Heterocedasticity for the simulated model:

Table (4 - 56) Comparisons of Detections Methods of Heterocedasticity for the simulated model:

Table Number in Comparisons Between Detection Methods	Maximum R^2	Minimum AIC	Minimum P.value
(4 - 42)	Harvey Test	Harvey Test	Harvey Test
(4 – 45)	White Test	Park Test	White Test
(4 – 47)	White Test	Harvey Test	Harvey Test
(4 – 49)	White Test	Glejser Test	White Test
(4 – 51)	Harvey Test	Harvey Test	Harvey Test
(4 – 53)	White Test	Glejser Test	White Test
(4 – 55)	White Test	Glejser Test	White Test & Glejser Test

Source: Researcher preparation 2020

We conclude from Table (4 - 56) that the best test that led to the detection of Heterocedasticity was White test, as it proved its best in helping to detect the problem when it was applied in the simulated model and the remedies, According to AIC the best tests is Glejser Test and Harvey Test.

4.17. Comparison of Remedies of Heterocedasticity for the simulated model:

Table (4 - 57) Comparisons of Remedies of Heterocedasticity for the simulated model:

Remedy	ratio of remedy to test
First	6 : 8
Second	1 : 8
Third	5 : 8
Fourth	4 : 8
Fifth	5 : 8
Sixth	1 : 8

Source: Researcher preparation 2020

From Table (4 - 57) we note that the best remedy led to remedy Heterocedasticity is First Remedy According to first assumption $\sigma_{ui}^2 = \sigma_u^2 X_i^2$, because it was proved that 6 out of the 8 detection methods led to the remedy, followed by the third and fifth Assumptions $\sigma_{ui}^2 = \sigma_u^2 \left[E\left(\hat{Y}_i\right)\right]^2$ and the logarithmic method $\log Y_i = \beta_o + \beta_1 \log X_i + U_i$ (By taking the logarithm) it where proven that 5 out of the 8 methods of detection led to the remedy of the problem by it.

4.18. Comparison of Remedies of Heterocedasticity for the both model:

Table (4 - 58): Comparison of Remedies of Heterocedasticity for the both model

Remedy	ratio of remedy to test of actual Model	ratio of remedy to test of simulated Model
First	1 : 8	6 : 8
Second	0 : 8	1 : 8
Third	1 : 8	5 : 8
Fourth	1 : 8	4 : 8
Fifth	7 : 8	5 : 8
Sixth	5 : 8	1 : 8

Source: Researcher preparation 2021

Table (4 - 58) clarify the comparison of Remedies of Heterocedasticity for the both mode

Chapter Five

Results and Recommendations

5.1. Results:

Firstly: for the Actual Data:

From the obtained results that we got from the actual model we may conclude that, after estimating MLR, it was found that it suffers from the problem of Heterocedasticity, as 7 out of 8 tests helped to detect that; in addition to we noted:

1. The value of the coefficient of determination of the original estimated model was 0.979; meaning that 97.9% of the changes that occur to the dependent variable are caused by the independent variables.
2. There is significant effect of study variables on government expenditures
3. The multiple linear regression model of actual data is significant.
4. There are differences between the common detection methods for the Heteroscedasticity problem when applied on actual data.
5. There are differences between the common remedies methods for the Heteroscedasticity problem when applied on the actual data
6. The best test that led to the detection of Heterocedasticity was White's Test, based on the determination coefficient and the probability value, which proved its advantage in helping to detect the problem when applied in the original model and the remedies in the actual model.
7. According to AIC the best test is Glejser Test in the actual model.
8. In the actual model the best remedy that led to the detection of the problem was the fifth remedy using the logarithm. It was proven that 7 out of the 8 detection methods led to the remedy, followed by sixth remedy (suggested by the researcher) based on the general case where it is proven that 5 out of the 8 methods of detection led to the remedy of the problem.

Secondly: for the Simulated Data:

From the obtained results we may conclude that, after estimating MLR for simulated data, it was found that it suffers from the problem of Heterocedasticity, as 4 out of 8 tests helped to detect that; in addition to we noted:

1. The value of the coefficient of determination of the main simulated estimated model was 0.997; meaning that 99.7% of the changes that occur to the dependent variable are caused by the independent variables.
2. The multiple linear regression model of simulated data is significant.
3. There are differences between the common detection methods for the Heteroscedasticity problem when applied on simulated data.

4. There are differences between the common remedies methods for the heteroscedasticity problem when applied on simulated data.
5. The best test that led to the detection of Heterocedasticity was White's Test, based on the determination coefficient and the probability value, which proved its advantage in helping to detect the problem when applied in the simulated model and the remedies.
6. According to AIC the best tests are Glejser and Harvey Tests.
7. The best remedy led to remedy Heterocedasticity was First Remedy According to first assumption $\sigma_{ui}^2 = \sigma_u^2 X_i^2$, because it was proved that 6 out of the 8 detection methods led to the remedy, followed by the third and fifth Assumptions i.e. $\sigma_{ui}^2 = \sigma_u^2 \left[E\left(\hat{Y}_i\right)\right]^2$ and $\log Y_i = \beta_o + \beta_1 \log X_i + U_i$ (By taking the logarithm) it where proven that 5 out of the 8 methods of detection led to the remedy of the problem by it.

Third: Generally

1. After applied in an actual model and a simulated model we conclude that:
a. the best test led to detection the problem of Heterocedasticity was White's Test
b. The best remedy that led to remove the problem was the fifth remedy (using the logarithm)
2. There are differences for the common detection methods for the problem of Heterocedasticity when applied to the actual data
3. There are differences for the common detection methods for the problem of Heterocedasticity when applied to the simulated data
4. There are significant differences for the remedies methods for the problem of Heterocedasticity when applied to the original data.
5. There are significant differences for the remedies methods for the problem of Heterocedasticity when applied to the simulated data.

5.2. Recommendations:

According to all these results we recommending:

1. Using White's Test to detect the problem of Heterocedasticity and
2. Remedy by taking algorithms in addition to conducting more studies about it.
3. Using newly discovered methods of detection and comparing them with White's test
4. Conducting more related study
5. Interest in collecting the data under study and verifying
6. Studying the fundamental differences in formulation among detection methods of Heterocedasticity which led to the discrepancy in the results between them.
7. Finding new criteria for determining preference of detection methods of Heterocedasticity and comparing it with the usual criteria
8. conduct study with more than one simulation data and another with a big sample size

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Appendix

Appendix (1): Actual Data

year	EXPE	GDP	INF	MS	EXCH_Of
1977	0.8	23.4	17.52	53.19	0.0004
1978	0.6	28.8	19.98	70.59	0.0004
1979	0.5	32.5	-1.04	93.65	0.0004
1980	1.1	39.7	70.79	123.21	0.0005
1981	1.3	49.5	22.02	156.97	0.0007
1982	1.6	70.4	28.43	216.10	0.0013
1983	1.9	95.9	31.66	277.45	0.0013
1984	2.0	118.1	30.75	326.15	0.0013
1985	2.7	153.6	47.17	601.81	0.0013
1986	5.5	202.2	28.35	775.60	0.0025
1987	6.6	364.8	24.05	1040.70	0.0035
1988	7.6	467.9	46.67	1420.90	0.0045
1989	13.9	825.6	75.30	2270.90	0.0045
1990	18.2	1,101.1	65.30	3164.50	0.0045
1991	63.4	1,926.6	119.10	5269.60	0.0050
1992	109.4	4,218.2	156.69	141.60	0.1000
1993	144.9	9,484.5	181.47	268.60	0.1300
1994	321.2	18,812.9	114.50	405.40	0.2200
1995	215.9	40,497.4	64.55	705.90	0.4000
1996	908.1	10,478.1	109.84	1166.00	1.2500
1997	1,281.3	16,137.4	48.39	1597.10	1.5800
1998	1,755.0	21,935.9	18.73	2069.50	1.9900
1999	2,269.0	27,058.8	18.89	2579.20	2.5200
2000	3,522.0	33,662.7	7.76	3466.70	2.5700
2001	4,186.0	40,658.6	4.40	4745.00	2.5900
2002	5,178.0	47,756.1	6.90	5632.70	2.6300
2003	7,362.0	55,733.8	6.25	7341.00	2.6100
2004	11,038.0	68,721.4	9.52	9604.50	2.5800
2005	13,847.0	85,707.1	8.59	13782.00	2.3100
2006	18,253.0	98,718.8	7.20	17871.80	2.1700
2007	20,971.0	114,017.5	6.21	19715.00	2.0200
2008	22,724.8	127,746.9	14.30	22933.20	2.0900
2009	21,025.9	139,386.5	11.24	28314.50	2.3300
2010	24,162.1	160,646.5	12.98	35497.90	2.6700
2011	32,193.0	186,689.9	18.08	41853.00	2.6700

year	EXPE	GDP	INF	MS	EXCH_Of
2012	29,821.5	243,412.9	35.60	58663.30	3.3000
2013	40,768.0	342,803.3	36.50	66445.70	5.7500
2014	55,652.6	471,295.4	36.91	77739.00	5.8300
2015	61,476.1	582,936.7	16.91	93642.90	6.0107
2016	62,195.0	693,514.6	17.75	120800.00	6.1815
2017	86,106.0	823,939.0	32.35	203368.00	6.6751
2018	116,090.0	1,176,630.0	72.94	430786.00	24.3527

Source: MoFEP[2] , CBOS[3] , MoT[4] , Ministry of Investment

Appendix (2) Simulated Data

No	GDP_s	EXPE_s	INF_s	EXCH_OF_s	MS_s
1	236547.5329	25805.78814	76.73925193	0.089800508	1928.786307
2	398856.2825	39431.59907	26.05076796	0.162279446	2250.267097
3	162932.8135	18247.70959	49.41453253	0.165553477	3055.576226
4	72858.9255	5961.205448	31.70480375	0.16908111	4516.58352
5	294095.2554	31714.25606	32.37225141	0.235682285	4615.393666
6	51869.70137	6844.776402	37.29233772	0.316599089	9363.411771
7	871649.8221	91012.21743	94.74619048	0.517058917	10191.57616
8	83465.87673	10088.77947	16.60414428	0.805033424	10531.84273
9	789161.5349	82543.083	137.1329994	1.009722766	11082.68156
10	316267.1	30952.10564	62.72185066	1.036974678	12506.34961
11	52599.84485	3881.190414	33.57766827	1.373014331	12743.37564
12	9681.548879	2513.287083	65.53636374	1.533354651	18925.75518
13	263914.5135	28615.57661	51.03134601	1.658116202	24590.77943
14	48469.9936	6495.725851	52.5336868	1.765595084	27852.99708
15	12204.51127	2772.321527	44.5105953	1.879762994	29281.11723
16	333376.8694	35747.32889	66.68766451	2.022499981	29642.36466
17	626.0078674	1455.002486	8.576098485	2.234041122	30142.89217
18	610739.2121	64224.32904	88.13430941	2.512031408	34008.06927
19	472796.7799	50061.67587	88.95052868	2.599032696	34542.10203
20	487256.1203	51546.22721	52.0401633	2.663382384	36858.00477
21	430924.65	45762.63283	8.391837008	2.937808575	39344.92534

[2] Ministry of Finance and Economic Planning
[3] Central Bank of Sudan
[4] Ministry of Trace

No	GDP_s	EXPE_s	INF_s	EXCH_OF_s	MS_s
22	135854.1245	12428.96987	7.951191025	2.967050561	40783.78067
23	269036.5019	26102.90464	124.6859175	3.008174382	43319.90337
24	85325.87364	7241.196382	89.12602488	3.117907683	51368.90507
25	207989.2339	22873.68612	0.224149623	3.303242243	57513.45587
26	847305.0616	88512.72258	63.69813161	3.427356607	58801.33703
27	429593.3982	42587.40183	3.97197471	3.974256682	65121.63346
28	258835.8268	28094.14403	87.02597758	4.055494149	66819.32598
29	16802.78563	3244.429811	57.74917266	4.40865858	69276.8944
30	123970.1214	14247.38071	75.05874725	4.597993145	74878.27436
31	84534.94725	7159.991376	34.10682455	5.772134529	74920.12919
32	336165.4068	36033.63012	21.659235	5.836292794	81332.67537
33	71865.52646	8897.762791	84.0897033	5.841752878	84870.96228
34	85977.05423	7308.053583	99.85920827	6.265916632	88348.82079
35	605377.8445	63673.8734	59.21111693	6.445060256	92485.95586
36	122466.2596	14092.97808	29.20369715	6.511474566	92873.61525
37	171089.7789	16046.64099	8.337656921	6.583440114	101469.9409
38	136642.1516	12509.8772	43.49734772	7.590710042	107042.5233
39	67028.35058	8401.126308	34.34024783	8.038146865	109974.4846
40	296522.8311	31963.49709	16.88949233	8.670532152	140325.6803
41	195283.6741	21569.19676	83.19678781	8.678189031	159864.3951
42	41810.90373	5812.032089	36.71649679	8.906929177	164124.7292

Source: Preparation by Researcher by Excel V.10, 2019