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The impact of macroeconomic indicators on inflation in Sudan during the period from 2000-2022

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Keywords :Inflation ،gross domestic product, macroeconomic indicators, exchange rate, government expenditure.

Abstract

The paper aimed to study the impact of macroeconomic indicators on inflation in Sudan during the period from .(2022-2000) The paper followed the econometrics approach through a linear regression model on time series data. The papers hypotheses were that there is a statistically significant relationship between the gross domestic product and government expenditure, and exchange rate on inflation. The paper reached the most important results, the most important of which is that the gross domestic product and exchange rate directly and positively affect the inflation rate, and that government expenditure inversely affects the inflation rate. The most important recommendations included the need to pay attention to reducing inflationary pressures with the aim of stopping the deterioration of the value of the Sudanese pound and then improving it. This can only be achieved by increasing the gross domestic product, which contributes to expanding the productive capacity of the economy, and reducing government expenditure on non-productive activities and increasing taxes to reduce inflation rates. The performance of macroeconomic indicators is considered a standard by which the economic performance of countries is measured. Therefore, we find that macroeconomic policies always work on To control the general level of prices by designing specific policies that reduce Inflation rates. Sudan, like other developing countries, has continued to suffer from the low performance of macroeconomic indicators, represented by an imbalance between aggregate demand and supply. In recent years, inappropriate economic policies have played a major role in the instability and high rates of inflation for long periods ،even if their intensity varies from period to another ،The high rate of inflation in Sudan in recent years is attributed to structural problems that have been associated with the Sudanese economy, as the government's growing expenditure has contributed greatly to the rise in inflation, especially since this spending is not matched by real production ،as it is financed by borrowing from the Central Bank, as recent years have witnessed a rise the growth rates of money supply in Sudan are steady due to several factors, the most important of which is the increase in the general budget financing deficit, the increase in government expenditure ،and the decrease in the state's public revenues, as the fiscal deficit in 2019 reached 11% of the gross

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domestic product, and public revenues (excluding grants) reached 5.4% Only of GDP in 2020 .So the budget deficit was financed by inflationary Finance, which led to an increase in the inflation rate, reaching 60% in 2018 ،and it continued to rise until it reached 230% in October 2020.(Annual report of the Bank of Sudan, P. 35.2020). Therefore, what are the macroeconomic indicators that affect inflation rates in Sudan? And to what extent do these macroeconomic indicators affect inflation rates ؟ Based on these questions, the paper's hypotheses were formulated as follows:

Paper hypotheses:

1-There is a statistical relationship between gross domestic product and inflation.

2-There is a statistical relationship between government expenditure and inflation.

3- There is a statistically significant relationship between exchange rate and inflation.

Paper objective:

The paper aims to measure the impact of macroeconomic indicators on inflation in Sudan during the period (2000-2022).

Paper importance:

The paper follows econometrics model to clarify the impact of macroeconomic indicators on inflation in Sudan by studying data, information and macroeconomic indicators during the study period from (2000-2022).

The paper's outputs also contribute to supporting and assisting the competent and relevant authorities in making the decisions and recommendations reached by the paper .

Paper methodology:

The paper relied on the descriptive analytical approach and the applied econometrics approach using the multiple linear regression model, specifically the Ordinary Least Squares (OLS) method in estimating the relationship between the study variables. The paper relied on time series data from secondary sources such as publications ،and specialized periodicals of the World Bank, Central Bank of Sudan, and Federal Ministry of Finance during The period from (2000 – 2022).

Paper Organization:

The paper included four axes as follows: first axis deals with inflation, its concept and types, and theories explaining inflation ،second axis deals with the Policies to treatment inflation, third axis reviews the performance of macroeconomic indicators and the development of inflation rates in Sudan (gross domestic product, government spending, and the exchange rate .(Fourth axis, it deals with building a model of the of macroeconomic indicators and its impact on inflation in Sudan, and evaluating the estimation results, results and recommendations.

Previous studies:

(Habab Al-Toum Sharafi (2015): The impact of inflation and the The study entitled exchange rate on the balance of payments in Sudan during the period from 2002 -

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2013). The aim of the research is to clarify the impact of inflation and the exchange rate on the balance of payments. The research followed the descriptive, analytical and standard approach using the statistical analysis program SPSS .The study reached results ،the most important of which is that an increase in inflation rates leads to an increase in the exchange rate deficit and thus the balance of payments deficit . Maryam Jameelah & Idris Osman:(2014) The study entitled The Determinants Of Inflation in Malaysia,The study aimed to find out the determinants of inflation in Malaysia by studying a large number of economic variables that have been studied in a number of other countries. The study used multiple regression to study the relationship .The study found that there is an inverse relationship between inflation and gross domestic product, interest rates, and government spending .While money supply is positively related, there is no relationship between imports and inflation . The study recommends the inclusion of other variables such as unemployment rate, exchange rate, discount rate, government revenue, export of goods and services and private consumption in order to identify the remaining factors that can explain inflation in Malaysia. (Amira Mohamed Bashir 2010). The study entitled Determinants of inflation in Sudan during the period from.2008-1980 The study aimed to know the factors that affect inflation rates in Sudan, and to study the phenomenon of inflation through a model that explains the behavior of the phenomenon .In which the researcher followed the descriptive approach and the standard approach in the analysis, and the study found that there is a direct relationship between import prices and inflation. Al-Dardiri Ismail Bilal(2006:(The study entitled The role of fiscal and monetary policy in controlling inflation in Sudan in During the period from 1970 - 2006, the aim of the research is to know the factors affecting inflation in Sudan ،The research methodology is the quantitative analysis approach to test the hypotheses. Specifically, quantitative analysis is used to test the hypotheses .Because of the regression represented by the least squares method to estimate the equation for the purpose of knowing the factors affecting the Inflation . Finally, the most important results of the research are: Structural factors are considered among the most important factors affecting inflation in Sudan and We can consider inflation in Sudan (structural (Monetary factors were also represented by the increase in the supply of money, which was measured in the study, an increase in Money supply (excessive issuance of money leads to high inflation rate).

First axis: inflation concept and types:

Inflation is considered one of the macroeconomic phenomena that preoccupied economists in the seventies and eighties of the last century, due to the large negative economic effects that inflation had on the economy in general. The goal of treating inflation and maintaining price stability is one of the basic goals that governments seek to achieve, which is considered an indicator of Government failure or success.

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Concept of Inflation:

Inflation is defined as a continuous rise in the cost of living, due to what the rise in prices leads to the increase in the cost of purchasing commodity groups that the consumer is accustomed to purchasing .There is another trend in defining inflation that focuses on its manifestations and effects. It defines inflation as a rise in the general level of prices and an increase in the means of purchase in the possession of the public without a corresponding increase in traded good.This means that inflation is not just the amount of money, nor is it just an increase in spending, as some might think .If the amount of money increased and that was followed by an increase in employment and consumer goods produced ،there would be no rise in prices.(Mohamad Abdalla, P.117 , 2018).

Types of inflation:

Demand Pull Inflation:

It is inflation due to demand as a large amount of money chasing a small amount of commodities, and this inflation lies in the tendency of prices to rise in the face of excess demand.

On the side of aggregate demand, high prices lead to a reduction in the volume of real money and push individuals to liquefy their interest-bearing financial assets (i.e. convert them into money for the purpose of satisfying their transactions .(Interest is the incentive for investment, and the decrease in investment continues until the original incentive (the rise in prices) stops.

On the aggregate supply side, we find that high prices increase the marginal productivity of the worker at each level of employment, i.e. the labor demand curve shifts to the right, and therefore we find that employment increases without a corresponding increase in wages(Farid Bashir, and Abdul Wahab, p. 43, 2012).

Cost Push Inflation :

This explanation of inflation depends on the phenomenon of change in costs on the effect of changes in money wages on the general level of prices .Or in the sense that higher wages push producers to estimate higher prices for goods and services at each level of use, since use and production are directly related through the production function, this means that each level of production will require a higher level of prices, and accordingly the aggregate supply curve shifts up.(Farid Bashir, and Abdul Wahab, op. Cit, p. 48, 2012).

Theories explaining inflation:

Economists presented many theories that try to provide an explanation for the nature and causes of inflation, and multiple criteria and classifications were used for these theories. From the beginning of the fifties until the beginning of the sixties of the twentieth century, the explanations of inflation were based on the concept of excess demand for goods and services .In this context, a distinction was made between the theories of attracting demand and paying alimony as an explanation for the

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phenomenon of inflation .With the beginning of the sixties of the same century, modern interpretations of the phenomenon of inflation emerged based on distinguishing between the role of economic variables and the role of non-economic factors in the formation of inflation. These explanations were known as market theories of inflation and non-market theories of inflation .Another trend emerged to interpret inflation ،called the structuralists, and they refuse to treat inflation as a purely monetary phenomenon. In contrast, they view inflation as a phenomenon with a socio-economic content that is organically linked to the phenomenon of underdevelopment and development challenges facing third world countries. (Farid Bashir, and Abdul Wahab, op. Cit, p. 54 , 2012).

Modern Explanations of Inflation:

With the beginning of the seventies of the twentieth century, the distinction appeared between the variables that explain inflation, whether they were economic or non-economic variables. The explanation of inflation through the interpretation of the behavior of trade units and prices using social and political variables.

The distinction between these two theories for the study of inflation focuses on the fact that the owners of the market theory believe that prices and wages change slowly in response to changes in market forces, whether actual or potential .The content of this is that the focus is on the fact that the increase in prices and wages occurs in response to potential actual conditions of market forces. As for the supporters of the school that depends on non-economic variables, they believe that prices and wages are taken independently of the state of demand in the markets for goods, services and labor.(Mohammad Abdulla ،op. Cit ،P.119 ,2018) .

Market theories of inflation :

A/ inflationary gap model:

The market theory of inflation is based on a clear distinction between conditions of unemployment and the state of full employment .The economist Keynes was the first to introduce this idea, and it was known as the inflationary gap. This idea is based on the distinction between full employment and equilibrium .Equilibrium may be achieved at levels of employment or employment that are higher or lower than the level of full employment, meaning that full employment is a state of balance between other cases.(Farid Bashir, and Abdul Wahab, op. Cit, p. 66, 2012).

The inflationary gap is the situation in which aggregate demand) aggregate spending) is higher than aggregate supply at the full employment level .In the sense that there is a surplus in demand for goods and services, and this surplus leads to an increase in the general level of prices and perhaps wages.

The inflationary gap may also occur as a result of the equality of aggregate supply and aggregate demand, but far from the level (output, income, employment) that achieves full employment .In other words, the inflationary gap occurs when the

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aggregate supply is equal to the total expenditure, and this equilibrium situation is higher than the full employment level.(Mohammad Abdullah ،op.Cit ،P.120,2018) .

B / Simple Phillips Curve Model :

As a result of the events that the world went through in the post-World War II period, the inflationary gap model proved incapable of explaining the economic reality, as full employment could not be reached except through a rise in the general level of prices. And through a historical study of the English economy for a period of one hundred years during the period from 1861-1957, the economist Phillips presented a curve known as the Phillips curve, through which he proved the existence of an inverse relationship between the inflation rate and the unemployment rate. In this curve, the change in the amount of money affects inflation and does not affect the output, meaning that reducing inflation rates is at the expense of surplus and increasing labor, and vice versa for the classics, that unemployment is constant.(Mohammad Abdullah ،op.Cit ،P.121,2018).

Non-market theories of inflation:

These theories are based on the assumption that wages and prices may rise independently of the state of demand for goods and services in the market, and these non-market theories are based on the fact that inflation is a reflection of social variables. As for the point of view that prices rise to the top due to non-economic variables, it was presented as an explanation for inflation in Britain after World War II, and this idea is based on the existence of monopolistic powers for trade units, and the dominance of the concept of monopolistic market structures. So the economic units, through monopoly power, increase the share of wages as a component of national income and protect living standards, and each unit tries separately to reduce its members in relation to the other units .However, the abnormal increase in wages would create a gap between them and others, prompting the others to try to demand an increase in wages to bridge this gap, and then the continuation of the upward trend in prices due to the increase in wages.(Mohammad Abdullah ،op. Cit ،P.123 , 2018). Compared to the competitive market, the industry that is concentrated in a monopolistic market has a greater willingness to accept higher wages, because the alternative is strikes and work stoppages by workers.

Structuralism's Explanation of Inflation:

From the beginning of the seventies of the last century, a new trend appeared in the interpretation of inflation called the term structuralists, and they refuse to treat inflation as a purely monetary phenomenon. On the other hand, they view inflation as a phenomenon with a comprehensive social and economic content that is organically linked to the phenomenon of underdevelopment and development challenges facing third world countries .It is represented in a group of structural imbalances of economic activity in its dimensions, whether objective, organizational, in-kind or monetary.(Mohammad Abdullah ،op. Cit ،P.126 .2018).

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Second axis: Policies to treatment inflation:

1-Classics, monetarists, and treatment of inflation:

Classical thought has two currents to address inflation, the monetary current on the one hand, and the supporters of the classical theory on the other hand.

Monetary school :Inflation and its growth are mainly attributed to monetary factors. Inflation is due to excessive monetary and financial issuance in particular, and poor organization of monetary and financial policy in general .The classical analysis involves a conclusion that says that monetary excess leads to a rise in prices, wages, and money incomes, but leaves the commodity aspect and the real conditions of people's well-being unchanged, that is, a large amount of money chases a small amount of goods. According to the supporters of this school, inflation is the result of the expansion of spending financed by credit or money creation, and this applies to the behavior of both the private and public sectors .Hence, the monetary treatment for inflation lies in the necessity of restricting bank credit to businessmen on the one hand, and reducing public spending and increasing taxes on the other hand.(Farid Bashir, and Abdul Wahab, op. Cit, p. 62, 2012).

2- Keynesin and the treatment of inflation:

According to the inflationary gap model, which was presented by Keynes, inflation is treated by eliminating the gap using the following methods :

First method:Through the money supply, as long as there is an increase in the general level of prices, the demand for money will increase even if the money supply is not increased by the monetary authority, which leads to a rise in the interest rate in the market, which in turn leads to investors being reluctant to make spending decisions .investment by reducing aggregate demand when the interest rate rises.

Second method :Through the effects that occur as a result of inflation, which are the redistribution of incomes. If inflation will result in a redistribution of incomes from those with a high marginal propensity to consume to those with a low marginal propensity to consume, then total consumer spending will lead to a decrease in aggregate demand to equalize the value .The real output (Y/P)t, and thus the inflationary gap disappears.(Farid Bashir, and Abdul Wahab, op. Cit, p. 64, 2012)

3- Structuralisms and treatment of inflation:

Structuralists believe that treating inflation must be done through systematic treatment, based on the fact that inflation is a group of structural and functional imbalances, and inflation is treated by eliminating its causes, which are closely linked to economic reality. The structuralists believe that the treatment of inflation is not achieved through the monetary workshop, as the monetarists see, and that the supply side or the production system must be looked at, such as achieving proportionality between production and consumption, establishing coordination between the productive sectors to eliminate bottlenecks, raise the efficiency of the national economy through productive, technological and administrative measures, and

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improve the distribution of income through a network ،Consistent income and price actions. (They i.e., structuralists) believe that there is a possibility for inflation to occur even if there is no increase in total spending due to the inflexibility of many sectors in the national economy, and the disproportionality between aggregate supply and aggregate demand.

Measures of inflation:(Inflation Index)

There are two indicators used to show the movement of change in prices and thus measures of inflation ،including:(Mohammad Abdalla,op.Cit, P.126, 2018).

1-Gross Domestic Product (GDP):

It is the sum of the monetary values of all final goods and services produced in an economy during a given period .A specific period known as his year . It means the number that expresses the relationship between the gross domestic product at the prices of a certain base year and the domestic product at current prices, and it is calculated by dividing the gross domestic product at current prices for a specific year by the gross domestic product at the prices of the base year (in constant prices) for the same year .It can be said that if the index figure for GDP is positive or negative and closer to zero, then this indicates the presence of economic stability. However, if the value of the number is far from zero (positive), then this indicates a rise in the general level of prices, and vice versa for a negative value.

2- Cost of Living Index: (Consumer Price Index)

This measure is considered one of the most common measures of inflation, as it reflects the amount of change in the gains that the average consumer can obtain, whether they are gains of goods or services. Analysts agree on the importance of the consumer price index as it reflects the deterioration that has occurred in the purchasing power of money .The relationship between the value of Money and the quantity of goods purchased have an inverse relationship. High prices for goods and services mean a decrease in the value of money and vice versa.

This is mathematically expressed by the following equation

prices ⁄ = Value of money

For example, a 100% increase in prices means a %50 decrease in the value of money. In order to calculate a correct index number that represents the changes occurring in the value of money, we must follow the following steps:

1-Choose sample goods:

A sample of goods must be chosen that are common and consumed by a specific group of society members and at the same time reflect general price trends. There are index numbers for wholesale goods ،retail goods, and consumer goods .This sample must be representative of price trends and a sample of the population whose commodity prices are to be studied, such as a household budget survey.

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2 - Choose the base year:

This year is used to compare the change in prices between two time periods, i.e. between the base year and the comparison year, i.e. the year in which prices are to be calculated. Its selection takes into account that the price levels in it are normal with the relative stability of economic variables .

3-Expressing commodity prices in percentages through the following relationship:

Index = The price of the commodity in the base year% * .100
The price of the commodity in the comparison year

Example: (1) How to calculate the inflation rate

We assume that a group of basic commodities is in one basket (CPI) and is consumed by all families and individuals. We assume that the number of these commodities is N=10.

$$CPI = W_1 P_1 + W_2 P_2 \ldots\ldots\ldots\ldots\ldots + W_{10} P_{10}$$

This is done using the weighted weight method

$$W_1 + W_2 \ldots\ldots\ldots\ldots\ldots + W_n = 1$$

Inflation is the increase in the consumer index either weekly, monthly or annually

$$P = \frac{CPI_1 - CPI_0}{CPI_0}$$

Where (P) is the inflation rate) ،CPI_0 (the index in the base year) CPI_1 (the index in the calculatedor expected year.

$$P = \frac{CPI_1}{CPI_0} - 1$$

The inflation rate affects real income.

$$\text{Real income} = \frac{\text{Nominal income}}{\text{general price level}} = Y_t = \frac{Y}{P}$$

Third axis: the performance of macroeconomic indicators and the evolution of inflation rates in Sudan:

The stability of the performance of macroeconomic indicators is considered a necessary need, to build local and international confidence in the business environment, and These economic indicators are considered a reflection of the interaction of aggregate demand and supply, and the low performance of these indicators leads to structural imbalances in the economy of any country .Sudan, like any other developing country, suffers from structural problems in the economy, so the need has arisen to .address these structural problems so that the Sudanese state is able to establish productive economic relations .Attracting investments, supporting the growth of companies, and improving foreign trade. These imbalances are linked

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to current economic indicators. All of the following.(Howaida Mahjoub Ibrahim,op. Cit, p .2016 ،61)

-Current government expenditure ،the budget deficit, and deficit financing have witnessed a steady rise in recent years, as the Statistics show that current spending increased in the period from 2010 to 2014 from 24 billion to 38.8 billion, i.e. 25% at a time when The policy adopted was to reduce Spending .This increase in the volume of current spending was not matched by a similar increase in non-public revenues. Oil after oil resources left the budget, which led to an increase in the resource gap and the budget deficit, and the Ministry of Finance was forced to resort to borrowing from the central bank to cover the deficit, and this led to an increase in inflationary pressures, as The fiscal deficit in 2019 reached 11% of the GDP, while the 2020 budget reflected a deficit of 1.6% billion dollars, and government spending represents %19 of the GDP.(Annual report of the Bank of Sudan. P. 35.2020).

-The Sudanese economy witnessed a clear decline in growth rates in the gross domestic product. A year ago, in) .2011 the year of separation), the growth rate in GDP decreased from 5.2% in 2010 to 1.9% in 2011, then 1.7% in 2012 .This is due to a number of reasons ،the most important of which is the secession of the South and the exit of oil resources .The structural imbalances that limit Production plays an additional role in the continued decline in growth rates, which led to an increase in imports by filling the supply gap. Local consumption and an increase in the effects of imported inflation on local prices, in addition to a decline in Growth rates are Structural imbalances related to production result in a continuous rise in production costs. production, which in turn led to an increase in inflationary pressures and a contraction in the Sudanese economy, as a result of the negative growth of the gross domestic product in 2018, when it decreased by 8.2%. In 2020, as a result of the outbreak of the Covid-19 epidemic, the per capita GDP decreased by 62% .During the past five years, the per capita GDP decreased from 1.910% US dollars in 2015 to 0.730 US dollars in 2020.(Guvas Asari et al., p. 43, 2020).

-The deterioration of the national currency exchange rate increases the impact of the external sector on rising prices. It also helps indirectly to raise inflationary pressures, as the impact of the price of ...Spending on inflation rates in Sudan is greater and more important than the effect of monetary changes, i.e. (the effect of the growth of the monetary supply), and the current instability of the exchange rate and the increasing gap between the official price and the parallel price, which has reached more than 25%, It created a climate that had a negative impact on foreign exchange sources, and this led to an acceleration of the parallel exchange rate below the official rate until its value reached 250 Sudanese pounds .One US dollar per person in 2020.(Guvas Asari et al., op. Cit., p. 46 2020).

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Inflation rates have evolved in Sudan:

Inflation is considered one of the most important macroeconomic indicators by which the level of economic performance of countries is measured. Therefore, we find that the macroeconomic Policies always works to control the general level of prices, by designing Certain policies work to reduce inflation rates, which in turn affects other economic variables, and it has Government expenditure has played a major role in the rise in inflation rates in Sudan, especially since this spending is not matched by This is real production, as it is financed by printing money .In order to facilitate the analysis of developments in inflation rates during the period under study ،they were divided into three periods :. (Abdel-Wahhab Othman, p, 42 , 2001)

First period of year 2000-2004:

During the period (2000-2004), the government adopted comprehensive structural and economic reform programs, which were based on consistency between macro and sectoral policies, by rationalizing spending and maintaining the size of To borrow from the banking system at the legal levels and the movement of liquidity, and this has helped Start producing And the export of oil, which subsequently generated foreign exchange, which led to stability in the exchange rate, and Accordingly, inflation rates began to decline successively until they reached a single correct number, and continued Inflation rates began to decline, and this was helped by the start of the production and export of oil, where it was The decline in inflation rates until it reached 8% at the end of 2000, then stabilized in 20 04as a result of the depletion in foreign exchange reserves, as inflation rates ranged between 5% and 8% during the period .The highest inflation rate was 8% in the year 2000 and the lowest was 5% in the year 2001. The arithmetic mean of the inflation rates during the period was 14.7 and its median was 8.6, and the inflation rates were distributed on the side. The standard deviation from the arithmetic mean is 13.8.(International Monetary Fund, Country Report No. 14/364, 2014)

Second period of year 2005-2015:

During this period, there were several factors affecting the Sudanese economy. The peace agreement in 2005 AD ،then the secession of the South in 2011, which led to an expansion in the rate of government expenditure, a decrease in the state's oil resources as a result of its transfer to the government of the south, the global crisis in In 2008, the volume of external transfers decreased and the external flows resulting from Exporting oil, which affected the balance of payments, the exchange rate and the budget deficit, and these effects were reflected in to inflation rates and gross domestic product .(World Bank, Sudan,Issue No. 02-2012 December 2012) .

During this period, inflation rates remained stable at single digits and did not rise again, even after the The peace agreement and the accompanying expansion in government spending were signed, and as a result of the global crisis, The secession of the south and the subsequent cessation of foreign investment flows and the

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withdrawal of petroleum resources from the country's revenues. Government and expected revenues from petroleum transportation The inflation rate rose to 14% in 2008, and the inflation rate continued to rise slightly, but it rose to 35.1% in 2012 and below 7.2% in 2006, as inflation rates continued to rise and reached its highest level in 2013, when it reached 37.1 ،% .its lowest level was in 2015, when it reached 16.9% .The arithmetic mean of inflation rates during this period was 14.4, and its median was 12.2 .Inflation rates were distributed with a standard deviation from the arithmetic mean of 9.1.(Annual reports of the Bank of Sudan for the years 2000-2021).

Third period of year 2015-2022:

During this period, the Sudanese economy suffered from a continuous and increasing financial deficit, an increase in government expenditure, and a decrease in the state's public revenues, as the budget deficit in 2019 reached 11% of the GDP, as public revenues (excluding grants) amounted to only 5.4% of the GDP .Total in 2020 . Therefore, the increase in government expenditure and the decrease in the state's general revenues made it necessary to finance the budget deficit by borrowing from the Central Bank, which led to an increase in the inflation rate, reaching 60% in 2018, and it continued to rise until it reached 230% in October 2020.(Annual report of the Bank of Sudan.op. Cit, P. 35.2020) .

Fourth axis: building model:

Expressing the direction of the relationship between the variables of the study in the form of a mathematical form, is based on what is presented by the theory of Interactive, and inflation here as an economic variable is similar to behavioral functions in that it is affected by some other economic variables. From this standpoint, the variables of the model were determined. Inflation, as a dependent variable, is known as the The value of which is determined according to the values taken by the independent variables.

Economic relations of the model:

Formulating a model of the impact of the performance of macroeconomic indicators on inflation in Sudan, in which econometrics models were used to test hypotheses related to economic relations in a quantitative form. The data dealt with in this model are inflation, gross domestic product, government spending, and the exchange rate during the period .(2022 -2000) According to the following model :

INF = f(GDP , GEX , OEX)

whereas:

INF : Inflation as measured by the price index (it is the continuous rise in the general level of prices of goods and services during a specific period of time.

GDP (Gross Domestic Product) is the sum of the monetary values of all final goods and services produced in an economy For a specific period known as the year.

GEX :Government expenditure (is the amounts spent by the government or any public legal entity with the intention of achieving a public benefit).

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OEX : The exchange rate (it is the price of the Sudanese pound against the US dollar, meaning that one unit of the dollar is equal to a number of Sudanese pounds).

Mathematical form of the model:

It is the number of equations contained in the econometrics model that explain the relationship between inflation as a dependent variable and a function of the independent variables, which are gross domestic product, government expenditure, and the exchange rate.

$INF = \beta0 + \beta1\ GDP + \beta2\ GEX + \beta3\ OEX + Ut$

Data analysis:

The accuracy of estimates of economic variables depends primarily on the size and nature of errors in the measurement of these variables. Therefore, the accuracy of the standard model must be improved through preliminary analysis of the data, especially data related to time series.(Tariq Muhammad Al-Rasheed et al., p. (45,2014 ،

Series stability test :

A time series is a set of observations whose data are unstable and related to each other, and this instability leads to unreliable predictions .There are many tests that can be applied to time series data, the most important of which are:

1-Testing unit roots : When testing unit roots, it is necessary to determine whether the variables under study are stationary at their level or when calculating the initial difference. There are several tests that can be used through program packages ready to test the stationarity of the series, the most important of which are :

1-1 Philips-perron Test:

The Philips-perron test to measure the accuracy of the data and the capabilities of the model to test the stillness and stability of the series or unit root, which is based on including a number of differences with time gaps until the problem of autocorrelation disappears .If the regression coefficient of the standard formula is equal to one, then the model leads to the existence of the unit root problem, which suffers from From the instability of the series.(Tariq Muhammad Al-Rasheed et al, p, 45,2014).

Table (1) Results of the Philips-perron test for stability of study variables

variables	Calculated value(Philips-perron test value)	The critical value is at 5% significance level.	The stability level of the series
IF	0.9877	3.004861-	The first difference
GDP	0.9998	3.004861-	The first difference
GEX	1.000	3.004861-	The first difference
OEX	1.000	3.004861-	The first difference

Source: the researcher using (Eviews)

It is known that if the value of the Philipss-perron test (calculated value) is greater than (critical value) at 5% significance level for a variable data series, this indicates the stability of the series. According to Table (1), after conducting the test, it was found that all variables stabilized in the first difference.

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1-2--Cointegration test:

Cointegration means the possibility of along-term balance between time series that are unstable in their levels. If the time series data are integrated of one rank, the estimated regression is real and no false.The Johansen test is used to determine the possibility of there being more than one vector of cointegration ،because the model contains more than one independent variable.

Table (2) Results of Johansen cointegration test

Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.843771	68.05891	47.85613	0.0002
At most 1	0.697861	29.07381	29.79707	0.0604
At most 2	0.165233	3.939543	15.49471	0.9083
At most 3	0.006970	0.146884	3.841466	0.7015

Source: the researcher using (Eviews).

Through the results of the cointegration test, it became clear that there is a one-way cointegration .This indicates the stability of the time series and the balance of the model in the long term, and that the instability of the data at its levels does not lead to a false estimate.

Estimation model:ug the ordinary least squarsines method(Eviews program).

Table (3) Results of estimating the linear model of the Inflation function.

Dependent Variable: IF				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.369251	3.408812	2.455181	0.0239
GDP	0.038324	0.005641	6.794430	0.0000
GEX	-0.000104	2.28E-05	-4.573879	0.0002
OEX	0.613136	0.131816	4.651460	0.0002
R-squared	0.985541	Mean dependent var		57.39130
Adjusted R-squared	0.983258	S.D. dependent var		98.19145
S.E. of regression	12.70499	Akaike info criterion		8.078637
Sum squared resid	3066.917	Schwarz criterion		8.276114
Log likelihood	-88.90432	Hannan-Quinn criter.		8.128302
F-statistic	431.6932	Durbin-Watson stat		1.880228
Prob(F-statistic)	0.000000			

Source: the researcher using (Eviews).

Estimation Command:

LS IF C GDP GEX OEX

Estimation Equation:

IF = C(1) + C(2)*GDP + C(3)*GEX + C(4)*OEX

Substituted Coefficients:

IF = 8.36925109489 + 0.0383240096509*GDP - 0.000104164307583*GEX + 0.613135645199*OEX

Through the standard analysis table No. (3) and looking at the (Coefficient) column, the sign of the categorical (Intercept) was positive (8.369251), which is consistent with economic theory and represents the intrinsic strength of the effect of inflation or the general level of prices, and the sign of the coefficient of GDP was positive

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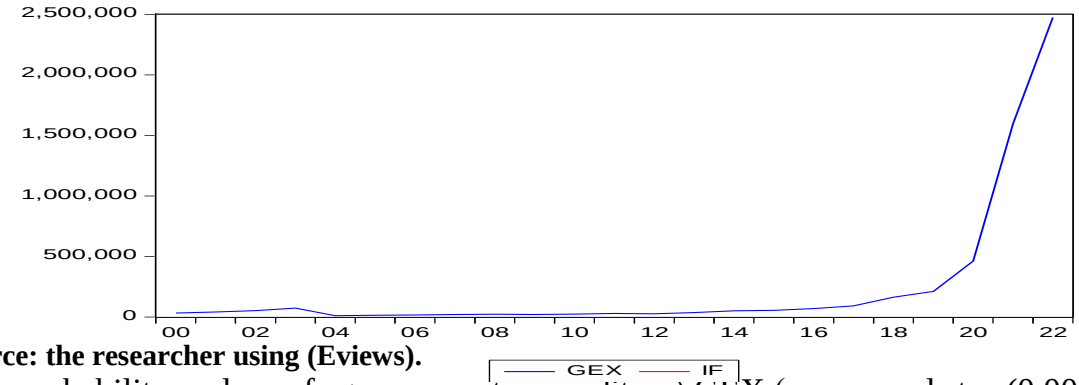
(0.038324).It contradicts the economic theory that assumes the existence of an inverse relationship between gross domestic product and inflation, and the sign of the government expenditure coefficient was negative (-0.000104). It fears the economic theory that assumes the existence of a direct relationship between inflation and government expenditure ،as well as the sign of the exchange rate coefficient is positive (0.613136), which it agrees with .Economic theory that assumes a positive, direct relationship between the exchange rate and inflation ،the sign of the categorical (Intercept (was positive (8.369251), which is consistent with economic theory and represents the intrinsic strength of the effect of inflation or the general level of prices, and the sign of the coefficient of GDP was positive.(0.038324) It contradicts the economic theory that assumes the existence of an inverse relationship between gross domestic product and inflation, and the sign of the government expenditure coefficient was negative .(0.000104-) It fears the economic theory that assumes the existence of a direct relationship between inflation and government expenditure ،as well as the sign of the exchange rate coefficient is positive (0.613136 ،(which it agrees with .Economic theory that assumes a positive, direct relationship between the exchange rate and inflation.

2-According to the statistical standard:

The significance of the estimated parameters: It is done through the standard analysis table No. (3), and by looking at the (Prob) column, the probability value of the gross domestic product (GDP) is equal to (0.0000), which is less than the level of significance (0.05), and it agrees with the economic theory, which states that :There is an inverse relationship between GDP and inflation, and increasing GDP contributes to reducing the inflation rate.

Figure No. (1) The relationship between GDP and inflation



Source: the researcher using (Eviews).

The probability value of government expenditure) GEX (was equal to (0.0002), which is less than the level of significance (0.05), and it agrees with the economic theory that assumes a direct relationship between government expenditure and inflation, meaning that government expenditure plays a major role in reducing the intensity of inflation. , especially since expenditure was matched by real production and an increase in GDP that led to a reduction in inflation.

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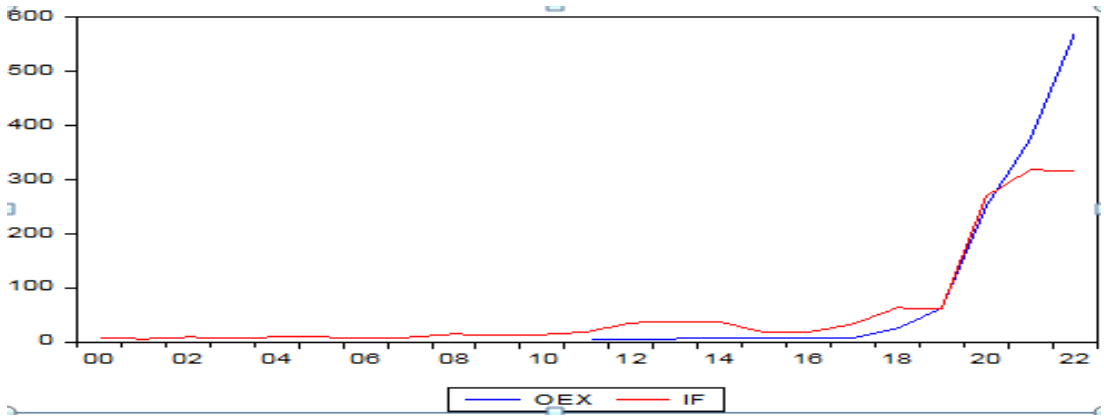
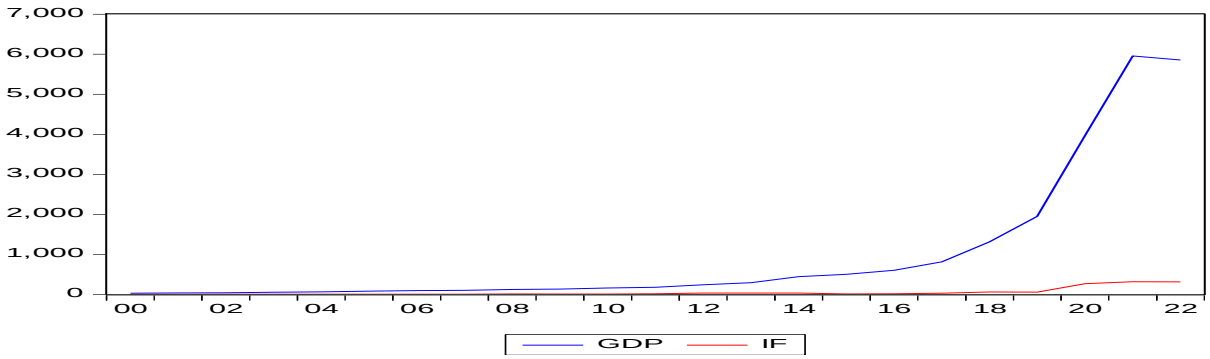
Figure (2) The relationship between GEX and inflation



Source: the researcher using (Eviews).

Likewise, the probability value of the exchange rate (OEX (was equal to ،(0.0000) which is less than the level of significance ،(0.05) and it agrees with the economic theory that assumes the existence of a positive, direct relationship between the exchange rate and inflation, as a constantly high exchange rate leads to a high inflation rate and vice versa.

Figure (3) The relationship between OEX and inflation



Source: the researcher using (Eviews).

Goodness of fit of the equation :This is done using the R-squared test or the adjusted coefficient of determination. If its value is high, this indicates the goodness of fit of the model. It is clear from Table (3) that the coefficient of determination is .(0.98) This means that 98% of the effects that What occurs in inflation is due to the independent variables, and the remainder ،%2 ،is the effect of random variables, which indicates the good fit of the estimated equation.

Significance of the model: Using the (F) test, if its probability value is less than the significance level (0.05), the regression model is significant, but if the probability value is greater than the significance level, the regression model is not significant . From Table No. (3), the probability value Prob(F-statistic) is (0.000000 .(It is less than the level of significance (0.05), so the model as a whole is significant.

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3- Evaluation according to the standard:

After conducting the analysis, it was found that the value of Durbin-Watson (1.92), and this value is close to the standard value (2), and this means that there is no problem of autocorrelation.

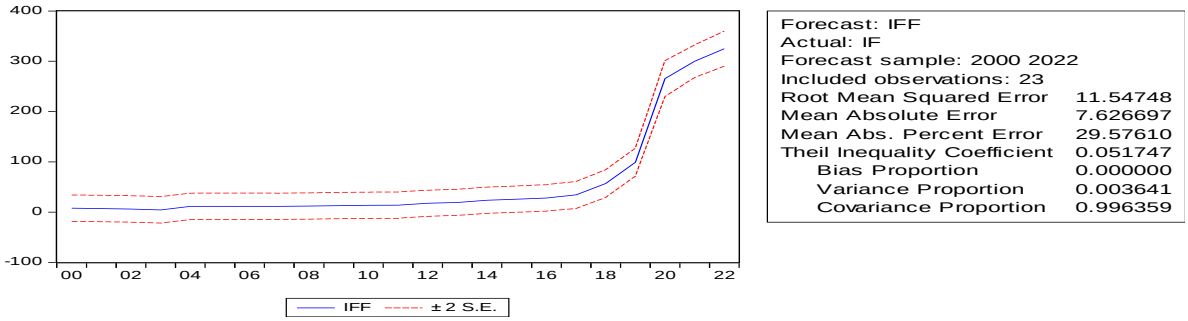
4-The problem of difference in variance: To discover the problem of difference in variance, the Heteroskedasticity Test was used: ARCH. It was found from Table No. (4) that the value of)(0.068698) Obs*R-squared) = and the probability value is equal to (0.7932 (Prob, and this value is greater than the level of significance (0.05), which means There is no problem with contrast difference

Table (4) ARCH test for variance

Heteroskedasticity Test: ARCH					
F-statistic			0.062648	Prob. F(1,20)	0.8049
Obs*R-squared	0.068698	Prob. Chi-Square(1)	0.7932		

Source: the researcher using (Eviews).

Figure No. (4) The model's ability to predict



Source: the researcher using (Eviws).

5-Model's ability to predict:

To determine the model's ability to predict, the Thiel's equality test was used. In this model, we find that the value of the Thiel's coefficient is equal to ‹(0.05) and whenever the value of the Thiel's coefficient is less than the correct one, the model has the ability to predict future values ‹as in Figure No .(4) .Below.

Results:

-There is a positive direct relationship between GDP and inflation, according to economic theory, which assumes the existence of an inverse relationship between GDP and inflation ‹meaning that in light of the stability of GDP and the lack of growth in real income and quantity of goods and services produced, this leads to an increase in the inflation rate and vice versa.

- There was an inverse relationship between government expenditure and inflation, according to economic theory, which assumes a direct relationship between government expenditure and inflation .This means that government expenditure plays a major role in reducing the intensity of inflation, especially if this government expenditure is offset by A real increase in GDP leads to a reduction in inflation.

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-There is a positive direct relationship between the exchange rate and inflation, according to economic theory, which assumes a positive relationship between inflation and exchange rate, meaning that there is a clear effect of the exchange rate on inflation rates, as a constantly high exchange rate leads to a high inflation rate and vice versa.

Recommendations:

- It is necessary to pay attention to reducing inflationary pressures in order to stop the deterioration of the value of the Sudanese pound and then improve it. This can only be achieved by increasing the gross domestic product, which contributes to expanding the productive capacity of the economy.
- Reducing government expenditure on non-productive activities and increasing taxes to reduce inflation rates.
-Maintaining the stability of exchange rates by implementing a policy of import substitution and encouraging exports.

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Appendix (1) Tables (1): Inflation rate ،groos domestic product, government expendiure ،official exchange rate, 2000-2022)

GEX	OEX	GDP	INF	Years
32200	2.571	33.662	8.1	2000
41860	2.587	40.658	4.9	2001
51790	2.633	42.835	8.3	2002
73900	2.608	55.733	7.4	2003
11038	2.582	68.721	8.4	2004
13843	2.435	83.298	8.5	2005
17096	2.171	96.611	7.2	2006
20806	2.021	106.527	8.1	2007
22440	2.091	124.609	14.3	2008
20025	2.235	135.570	11.2	2009
24162	2.237	162.203	13.1	2010
28573	2.485	182.689	18.1	2011
26272	4.351	243.412	35.1	2012
36178	5.591	294.630	37.1	2013
50632	5.540	447.827	36.9	2014
54476	6.030	505.9374	16.9	2015
69099	6.180	605.5140	17.8	2016
91368	6.680	815.8554	32.6	2017
162792	24.33	1317.000	62.8	2018
211057	62.00	1950.100	60.1	2019
462797	250.00	3974.000	269.3	2020
1597616	375.00	5958.000	318.2	2021
2474525	571.00	5856.893	315.6	2022

Source: Annual reports of the Central Bank of Sudan form 2000-2022 .

Appendix (2) Estimating the linear model of the Inflation function.

Dependent Variable: IF				
Method: Least Squares				
Date: 11/20/23 Time: 16:17				
Sample: 2000 2022				
Included observations: 23				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	8.369251	3.408812	2.455181	0.0239
GDP	0.038324	0.005641	6.794430	0.0000
GEX	-0.000104	2.28E-05	-4.573879	0.0002
OEX	0.613136	0.131816	4.651460	0.0002
R-squared	0.985541	Mean dependent var		57.39130
Adjusted R-squared	0.983258	S.D. dependent var		98.19145
S.E. of regression	12.70499	Akaike info criterion		8.078637
Sum squared resid	3066.917	Schwarz criterion		8.276114
Log likelihood	-88.90432	Hannan-Quinn criter.		8.128302
F-statistic	431.6932	Durbin-Watson stat		1.880228
Prob(F-statistic)	0.000000			

Source: the researcher using (Eviews).

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Appendix (3) Heteroskedasticity Test: ARCH

Heteroskedasticity Test: ARCH				
F-statistic	0.062648	Prob. F(1,20)		0.8049
Obs*R-squared	0.068698	Prob. Chi-Square(1)		0.7932
Test Equation:				
Dependent Variable: RESID^2				
Method: Least Squares				
Date: 11/20/23 Time: 17:29				
Sample (adjusted): 2001 2022				
Included observations: 22 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	146.9325	77.49753	1.895963	0.0725
RESID^2(-1)	-0.055674	0.222431	-0.250297	0.8049
R-squared	0.003123	Mean dependent var		139.4031
Adjusted R-squared	-0.046721	S.D. dependent var		327.4324
S.E. of regression	334.9941	Akaike info criterion		14.55261
Sum squared resid	2244421.	Schwarz criterion		14.65180
Log likelihood	-158.0787	Hannan-Quinn criter.		14.57598
F-statistic	0.062648	Durbin-Watson stat		1.997530
Prob(F-statistic)	0.804911			

Source: the researcher using (Eviews).

Appendix. (4) Johansen cointegration test

Date: 11/20/23 Time: 17:18				
Sample (adjusted): 2002 2022				
Included observations: 21 after adjustments				
Trend assumption: Linear deterministic trend				
Series: IF GDP GEX OEX				
Lags interval (in first differences): 1 to 1				
Unrestricted Cointegration Rank Test (Trace)				
Hypothesized		Trace	0.05	
No. of CE(s)	Eigenvalue	Statistic	Critical Value	Prob.**
None *	0.843771	68.05891	47.85613	0.0002
At most 1	0.697861	29.07381	29.79707	0.0604
At most 2	0.165233	3.939543	15.49471	0.9083
At most 3	0.006970	0.146884	3.841466	0.7015
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
* denotes rejection of the hypothesis at the 0.05 level				
**MacKinnon-Haug-Michelis (1999) p-values				

Source: the researcher using (Eviews).

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Appendix (5) Breusch-Godfrey Serial Correlation LM Test:

Breusch-Godfrey Serial Correlation LM Test:				
F-statistic	1.663778	Prob. F(2,17)		0.2188
Obs*R-squared	3.765027	Prob. Chi-Square(2)		0.1522
Test Equation:				
Dependent Variable: RESID				
Method: Least Squares				
Date: 11/20/23 Time: 17:30				
Sample: 2000 2022				
Included observations: 23				
Presample missing value lagged residuals set to zero.				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	3.084110	3.720449	0.828962	0.4186
GDP	-0.006633	0.006679	-0.993086	0.3346
GEX	-4.99E-05	3.96E-05	-1.260419	0.2245
OEX	0.261643	0.200470	1.305148	0.2092
RESID(-1)	0.433443	0.388729	1.115026	0.2804
RESID(-2)	-0.627789	0.349376	-1.796888	0.0901
R-squared	0.163697	Mean dependent var		-4.02E-15
Adjusted R-squared	-0.082275	S.D. dependent var		11.80700
S.E. of regression	12.28311	Akaike info criterion		8.073786
Sum squared resid	2564.872	Schwarz criterion		8.370002
Log likelihood	-86.84854	Hannan-Quinn criter.		8.148283
F-statistic	0.665511	Durbin-Watson stat		2.008213
Prob(F-statistic)	0.654657			

Source: the researcher using (Eviews).

Appendix (6) Inflation has a unit root

Null Hypothesis: IF has a unit root				
Exogenous: Constant				
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel				
			Adj. t-Stat	Prob.*
Phillips-Perron test statistic			0.646144	0.9877
Test critical values:	1% level		-3.769597	
	5% level		-3.004861	
	10% level		-2.642242	
*MacKinnon (1996) one-sided p-values.				
Residual variance (no correction)				1947.338
HAC corrected variance (Bartlett kernel)				1974.779
Phillips-Perron Test Equation				
Dependent Variable: D(IF)				
Method: Least Squares				
Date: 11/20/23 Time: 17:13				
Sample (adjusted): 2001 2022				
Included observations: 22 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
IF(-1)	0.082025	0.122643	0.668807	0.5113
C	10.23248	11.34540	0.901905	0.3778
R-squared	0.021876	Mean dependent var		13.97727
Adjusted R-squared	-0.027030	S.D. dependent var		45.66941
S.E. of regression	46.28253	Akaike info criterion		10.59391
Sum squared resid	42841.44	Schwarz criterion		10.69310
Log likelihood	-114.5331	Hannan-Quinn criter.		10.61728
F-statistic	0.447302	Durbin-Watson stat		1.931798
Prob(F-statistic)	0.511265			

Source: the researcher using (Eviews).

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Appendix (7) gross domestic product has a unit root

Null Hypothesis: GDP has a unit root				
Exogenous: Constant				
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel				
			Adj. t-Stat	Prob.*
Phillips-Perron test statistic			2.120581	0.9998
Test critical values:	1% level		-3.769597	
	5% level		-3.004861	
	10% level		-2.642242	
*MacKinnon (1996) one-sided p-values.				
Residual variance (no correction)				261523.5
HAC corrected variance (Bartlett kernel)				283100.7
Phillips-Perron Test Equation				
Dependent Variable: D(GDP)				
Method: Least Squares				
Date: 11/20/23 Time: 17:12				
Sample (adjusted): 2001 2022				
Included observations: 22 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	0.181777	0.079886	2.275455	0.0340
C	122.2011	130.3747	0.937307	0.3598
R-squared	0.205646	Mean dependent var		264.6923
Adjusted R-squared	0.165928	S.D. dependent var		587.2866
S.E. of regression	536.3542	Akaike info criterion		15.49397
Sum squared resid	5753517.	Schwarz criterion		15.59316
Log likelihood	-168.4337	Hannan-Quinn criter.		15.51734
F-statistic	5.177697	Durbin-Watson stat		1.369000
Prob(F-statistic)	0.034032			

Source: the researcher using (Eviews).

Appendix (8) government expenditure has a unit root

Null Hypothesis: GEX has a unit root				
Exogenous: Constant				
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel				
			Adj. t-Stat	Prob.*
Phillips-Perron test statistic			6.694053	1.0000
Test critical values:	1% level		-3.769597	
	5% level		-3.004861	
	10% level		-2.642242	
*MacKinnon (1996) one-sided p-values.				
Residual variance (no correction)				3.38E+10
HAC corrected variance (Bartlett kernel)				2.54E+10
Phillips-Perron Test Equation				
Dependent Variable: D(GEX)				
Method: Least Squares				
Date: 11/20/23 Time: 17:15				
Sample (adjusted): 2001 2022				
Included observations: 22 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
GEX(-1)	0.678208	0.123765	5.479823	0.0000
C	14831.90	44721.64	0.331649	0.7436
R-squared	0.600228	Mean dependent var		111014.8
Adjusted R-squared	0.580239	S.D. dependent var		297785.5
S.E. of regression	192932.1	Akaike info criterion		27.26457
Sum squared resid	7.44E+11	Schwarz criterion		27.36376
Log likelihood	-297.9103	Hannan-Quinn criter.		27.28794
F-statistic	30.02846	Durbin-Watson stat		2.178017
Prob(F-statistic)	0.000023			

Source: the researcher using (Eviews).

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Appendix (9) Exchange rate has a unit root

Null Hypothesis: OEX has a unit root				
Exogenous: Constant				
Bandwidth: 0 (Newey-West automatic) using Bartlett kernel				
			Adj. t-Stat	**Prob.***
Phillips-Perron test statistic			**6.641503**	**1.0000**
Test critical values:	**1% level**		**-3.769597**	
	5% level		**-3.004861**	
	10% level		**-2.642242**	
***MacKinnon (1996) one-sided p-values.**				
Residual variance (no correction)				**1083.860**
HAC corrected variance (Bartlett kernel)				**1083.860**
Phillips-Perron Test Equation				
Dependent Variable: D(OEX)				
Method: Least Squares				
Date: 11/20/23 Time: 17:16				
Sample (adjusted): 2001 2022				
Included observations: 22 after adjustments				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
OEX(-1)	**0.539662**	**0.081256**	**6.641503**	**0.0000**
C	**6.842615**	**7.897654**	**0.866411**	**0.3965**
R-squared	**0.688034**	**Mean dependent var**		**25.83768**
Adjusted R-squared	**0.672436**	**S.D. dependent var**		**60.33020**
S.E. of regression	**34.52892**	**Akaike info criterion**		**10.00798**
Sum squared resid	**23844.93**	**Schwarz criterion**		**10.10717**
Log likelihood	**-108.0878**	**Hannan-Quinn criter.**		**10.03134**
F-statistic	**44.10956**	**Durbin-Watson stat**		**1.860503**
Prob(F-statistic)	**0.000002**			

Source: the researcher using (Eviews).

Appendix No. (10) Descriptive statistics for variables.

	IF	**GDP**	**GEX**	**OEX**
Mean	**57.39130**	**1004.447**	**243241.1**	**58.49383**
Median	**16.90000**	**182.6890**	**41860.00**	**2.633000**
Maximum	**318.2000**	**5958.000**	**2474525.**	**571.0000**
Minimum	**4.900000**	**33.66200**	**11038.00**	**2.021000**
Std. Dev.	**98.19145**	**1779.868**	**589105.0**	**143.8395**
Skewness	**2.110241**	**2.081985**	**3.055846**	**2.659634**
Kurtosis	**5.703984**	**5.891566**	**11.12176**	**8.940759**
Jarque-Bera	**24.07716**	**24.62898**	**99.01092**	**60.93776**
Probability	**0.000006**	**0.000004**	**0.000000**	**0.000000**
Sum	**1320.000**	**23102.28**	**5594545.**	**1345.358**
Sum Sq. Dev.	**212114.3**	**69694497**	**7.63E+12**	**455175.8**
Observations	**23**	**23**	**23**	**23**

Source: the researcher using (Eviews).

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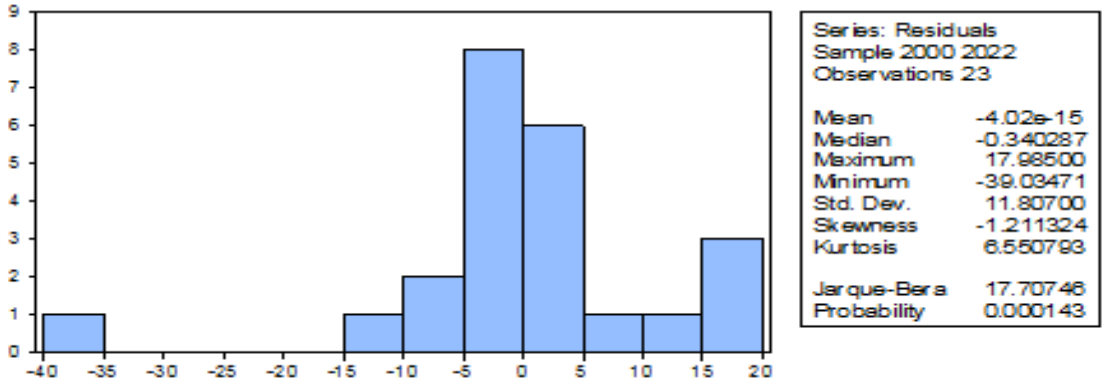
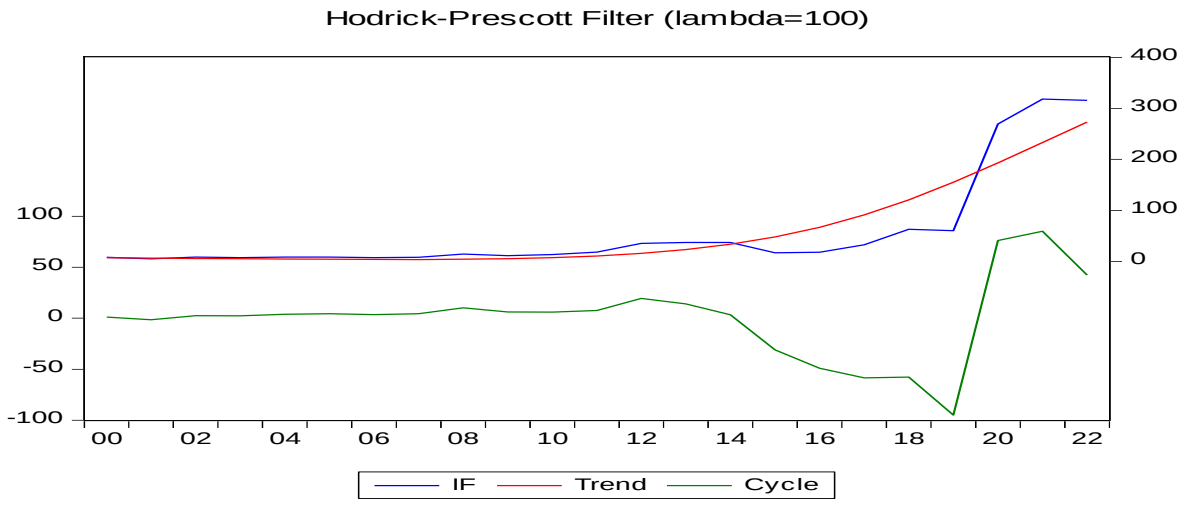
Appendix No. (11) Natural distribution of residuals



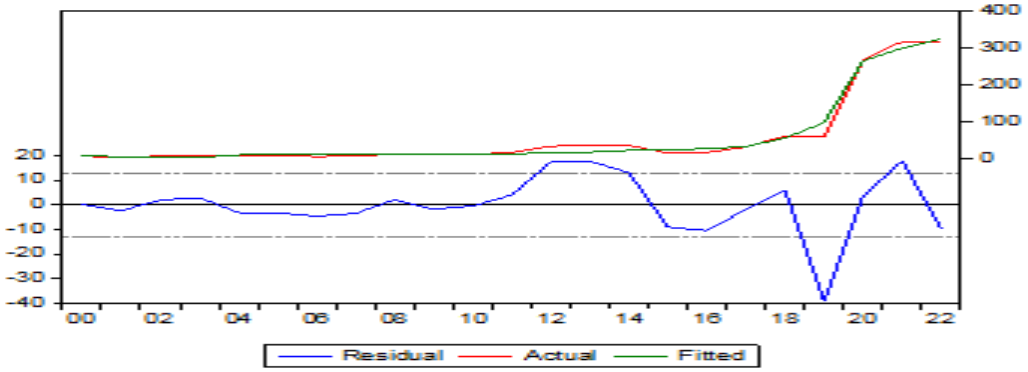
Source: the researcher using (Eviews).

Appendix (12) inflation & Trend & Cycle & model of inflation



Source: the researcher using (Eviews).

Appendix (13) residual & actual & fited model of iinflation.



Source: the researcher using (Eviews).