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Testing the Ability of Keynesian Phillips Curve Dynamics to Affect the Sudan's Real Economic Growth During the Period (2000-2022)

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إختبار قدرة ديناميكيات منحنى فيلبس الكينزي في التأثير على معدل نمو إقتصاد السودان خلال الفترة من (2000-2022)

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Abstract:
The study tested\the ability of Keynesian Phillips curve dynamics to affect the Sudan's real economic growth during the period (2000-2022), and used the econometrics methodology through the nonlinear autoregressive distributed lagged mode (NARDL), and the results revealed that there is a long-run equilibrium relationship between Keynesian Phillips curve dynamics and real economic growth, the imbalance is corrected by -3.27, that is, within approximately three months, and the increase in the inflation and unemployment rates by 1% leads to a decrease in the real economic growth by -0.15, -0.52, while a decrease in the inflation rate leads to a decrease in the real economic growth, which means that the real economic growth is inflexible to a decrease in the inflation rate, and the decrease in the unemployment rate by 1%, leads to an increase in the real economic growth by 0.37, but this increase is statistically not significant, it recommended that to choose the appropriate economic policy that works to achieve desirable rates of inflation and unemployment in order to reach a higher level of real economic growth.

Keywords: Keynesian Phillips curve dynamics, real economic growth, nonlinear autoregressive distributed lagged model.

الملخص
إختبرت الدراسة قدرة ديناميكيات منحنى فيلبس الكينزي في التأثير على معدل نمو إقتصاد السودان خلال الفترة من 2000-2022م، وإستخدمت منهجية الإقتصاد القياسي من خلال نموذج الإنحدار الذاتي ذو الفجوات الموزعة غير الخطي NARDL، وكشفت النتائج عن وجود علاقة عكسية توازنية طويلة الأجل بين ديناميكيات منحنى فيلبس الكينزي ومعدل النمو الإقتصادي، والإختلال في التوازن يصحح بمقدار 3.27-، أي خلال أربعة أشهر تقريباً، وأن الزيادة في معدلي التضخم والبطالة بنسبة 1% تؤدي إلى إنخفاض معدل النمو الإقتصادي بحوالي 015- ، 0.52-، بينما إنخفاض معدل التضخم يؤدي إلى إنخفاض معدل النمو الإقتصادي، مما يعني أن معدل النمو غير مرن للإنخفاض في معدل التضخم، أما الإنخفاض في معدل البطالة بنسبة 1% يؤدي إلى الزيادة في معدل النمو بحوالي 0.37، إلا أن هذه الزيادة غير معنوية

إحصائياً، وأوصت بإختيار السياسة الإقتصادية المناسبة التي تعمل على تحقيق معدلات للتضخم والبطالة يكون مرغوب فيهما بقصد الوصول إلى مستوى أعلى من النمو الإقتصادي.

الكلمات المفتاحية: ديناميكيات منحنى فيلبس الكينزي، معدل النمو الإقتصادي، نموذج الإنحدار الذاتي ذو الفجوات الموزعة غير الخطي.

Introduction

Many industrialized countries have come to rely in their economic activities on Phillips curve condition, and what a certain rate of unemployment and a certain rate of inflation indicate to. Then they choose a monetary and financial policy that determines the demand that ensures the achievement of these two desirable rates, Philips curve, holds that inflation and unemployment have a stable and inverse relationship. The theory claims that inflation comes with economic growth, which is lead to more jobs and a lower unemployment rate. However, the basic concept has been proven empirically, because of the occurrence of a recession in 1970 when there were high levels of both inflation and unemployment, or what is called stagflation, or in other words, the presence of a weak rate of unemployment commensurate with a rapid rise in nominal wages, and vice versa.

On this basis, it was concluded that there is a decreasing function between the two indicators, which means that there is an inverse empirical relationship between the rate of increase in the nominal wage and the unemployment rate. Sudan's economy become suffering from a continuous increase in unemployment and inflation rates which has a negative effect on the real economic growth, lead to deterioration in the standard of living, especially the poor members of society.

Problem

It can be formulated in the form of questions as follows:

What is the impact of Keynesian Phillips curve dynamics on the Sudan's real economic growth?

How we can estimate this impact?

Study importance

Analyzing the ability of Keynesian Phillips curve dynamics to influence the growth rate of Sudan real GDP, enables the development of appropriate economic policies that help the economic authorities in reducing their negative effects on the economy and society.

Objectives

The study aims to test the ability of Keynesian Phillips curve dynamics (inflation and unemployment rates) to influence the Sudan's real economic growth during the period 2000-2022.

The study method

The study used econometric methodology by relying on time series analysis and non-linear autoregressive distributed lagged model NARDL, during the study period that witnessed quasi-cyclical economic fluctuations in Sudan's economy.

The study hypotheses

- There is a long-run equilibrium relationship between Keynesian Phillips curve dynamics and real economic growth.
- The dynamics of Keynesian Phillips curve has a negative impact on the real economic growth.
- There is stagflation as a result of the simultaneous rise in the dynamics of the Phillips curve.

Literature review:

Anfal, Boukathir's study (2022), the impact of reducing unemployment on inflation under the Phillips curve in Algeria, mainly aims to know the extent to which the Phillips curve applies to the Algerian case by knowing the extent of the effects of reducing unemployment rates on inflation rates during the period from 2018-2001, which is the period corresponding to the adoption of programs economic revival, one of whose main goals was to reduce unemployment rates, and it was concluded that, despite the nature of the inverse relationship between unemployment and inflation, the response rate The limited scope makes the Phillips curve invalid in the Algerian case, as inflation is sensitive to unemployment according to this approach. As for the Algerian case, unemployment explains only 11.92% of the fluctuations occurring in inflation according to the coefficient of determination R^2, and unemployment has no significant effect on inflation in the Algerian case according to the t-statistic, which is due to Weak response to the relative stagnation in the rate of change in the money wage towards an increase.

Tahrawi's study (2022), a standard modeling of the effect of the Phillips curve on economic growth in Algeria for the period 1991-2019, and aimed to highlight the effect of the relationship that exists between the two economic indicators that represent the Phillips curve, which are: unemployment rates. And inflation and their impact on economic growth through studying the causal relationship using the toda yamamoto causality test and standard estimation using the autoregressive distributed lagged model (ARDL), which showed the absence of an impact of the Phillips curve in general on economic

growth, but it showed the presence of the impact of each indicator separately, and showed the existence of a long-rum causality relationship of the effect of unemployment rates on economic growth, as standard modeling has shown, the presence of an effect of inflation on economic growth in the long-run, and finally the absence The causality between inflation and unemployment, which is called stagflation in the Algerian economy.

Essam's study (2020), the new Keynesian Phillips curve, an econometric study of a sample of Arab countries during the period 1991 - 2018, and aimed to explain the dynamics of inflation in a sample of Arab countries, and worked to estimate the original Phillips curve, supported by adaptive expectations, and the new Keynesian Phillips curve using measurement tools. The economist's study of panel data concluded that the new Keynesian Phelps curve is capable of explaining the inflation dynamics in the Arab countries based on the soundness of the model estimated from statistical and economic aspects, as well traditional models confirmed that there is no relationship between unemployment and inflation in Arab countries in the long run due to the weak coefficient of determination and the absence of significant parameters.

Munir's study(2014), Unemployment and inflation in Malaysia using the error correction model, aimed to econometrically analyze the relationship between the unemployment rate and the inflation rate in developing countries in general and Malaysia in particular, and used the error correction model, and concluded that there is a balanced relationship between the unemployment rate and the inflation rate in Malaysia, and therefore the results of this study support the validity of the Phillips curve hypothesis.
- Hamed's study (2013), The Impact of Macroeconomic Variables on Wage Levels in Sudan for the Period (1970-2009). This study formulated a simultaneous standard model that included five equations related to macroeconomic variables, where the three-stage least squares method was used and the study recommended be attention to unemployment due to its impact. The negative impact on the economy and linking wage increases to increased production. Wage increases should not be financed with inflationary financing because that leads to an increase in prices and thus an increase in the cost of living, which inevitably leads to the erosion of wages.

Keynesian Phillips curve dynamics and Sudan's real economic growth:

The inflation rate and the unemployment rate are considered among the main indicators that have a direct impact on the real economic growth overall economy. Alban Phillips (1914 - 1975) confirmed through his research in the British economy during the period (1861-1957) that the relationship between the rate of change in total wages and the rate of Unemployment is a non-linear inverse relationship (Essam, 2020, p. 2), as under inflation conditions, the aggregate demand for goods and services and work increases, the unemployment rate decreases, and at the same time wages increase, then income and demand for goods increase, thus prices rise, and the opposite happens in the case of recession and depression.

Followers of the Keynesian approach argued that the basis for analyzing the dynamics of the Phillips curve lies on the exchange between unemployment and inflation rates, meaning that as the inflation rate rises, output will increase and the unemployment rate will decrease, and that the flexibility of prices and wages and surplus labor supply are considered pressure tools to accept low-wage work (Saleh, 2013, pp.358-359), according to the Phillips curve hypothesis, that when the unemployment rate is low, this leads to an increase in demand for products and services. As a result, prices in the economy rise and inflation rates increase. When the unemployment rate is high, there is a decrease in aggregate demand, which leads to lower prices. This indicates that it is difficult to achieve the macroeconomic goals of high employment rates and low inflation. Nominal economic growth refers to the complete rise in the value of products and services over time. However, an increase in the general level of prices in the economy can lead to an increase in the value of products and services. Therefore, when calculating the nominal economic growth rate, the effect of inflation is not taken into account.

Accordingly, the real economic growth results from subtracting the percentage increase in the general level of prices from the nominal economic growth, that is, by isolating the effect of inflation. This depicts the actual growth in the real volume of goods and services in the economy, but if the unemployment rate reaches a low level at the macroeconomic level, this means that more productive labor has been employed, which works to increase output, which indicates that the economy will grow at a rapid real rate that provides the total demand for the macroeconomic economy, and vice versa When the unemployment rate is high, there are more people unemployed, which may indicate that the economy is producing less real output overall.

Inflation:

We note from figure no (1) that the period from 2000-2022 witnessed an irregular development in the inflation rate in the Sudan's economy. The lowest inflation rate about 4.9% in the year 2001, so the extraction and export of Sudan's oil had a significant impact on this decline, while its highest rate about 359%, in the year 2021, and this increase came as a result of the deterioration of the political and

economic conditions, and adopting some policies such as (lifting subsidies on essential goods, floating the currency).

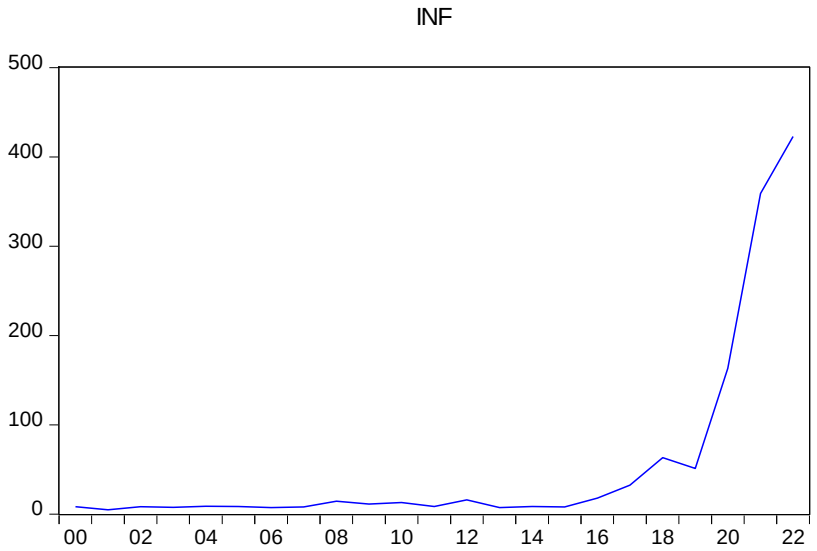


Figure (1): The inflation rate in Sudan during the period 2000-2022.

Unemployment:

The unemployment rate in the Sudan's economy witnessed a noticeable fluctuation due to the weakness of the policies used to reduce unemployment because of their negative effects on real economic growth. We notice from figure no (2) below that the lowest unemployment rate was achieved reached (13) in the year 2009, and the highest unemployment rate reached (19.18) and that was in the year 2021.

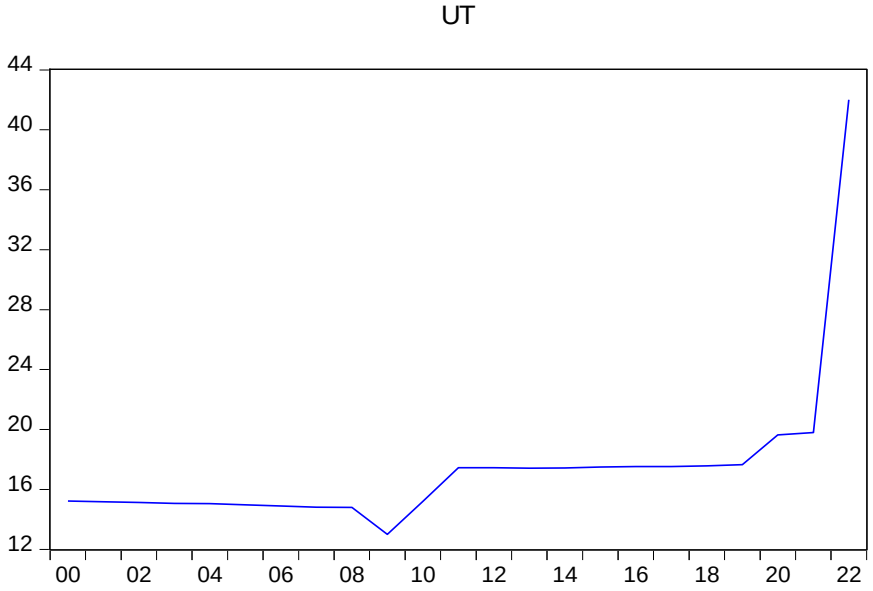


Figure (2): The unemployment rate in Sudan during the period 2000-2022.

Real economic growth:

We find that the macroeconomic constantly aims to increase the real economic growth, and therefore seeks to activate economic policies that work to reduce the impact of Keynesian Phillips curve dynamics due to its direct and indirect effects. We note from figure no (3) that the lowest real economic growth rate achieved during the study period reached (-3.6) in the year 2020, while the highest real economic growth rate reached (10.9) in the year 2007.

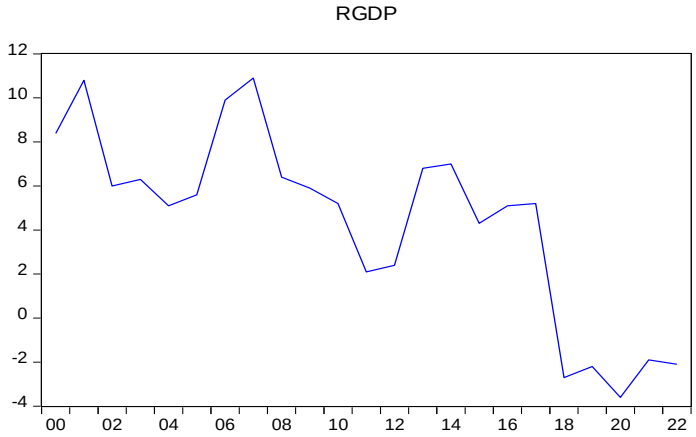


Figure (3): The real economic growth in Sudan during the period 2000-2022.

Methodology:

1- The study model:

The relationship between Keynesian Philip curve dynamics and Sudan's real economic growth can be formulated as follows:

$$\mathrm{RGDP} = \propto_0 + \propto_1 \mathrm{INF} + \propto_2 \mathrm{U_t} \dots\dots\dots (1)$$

Whereas: RGDP = real economic growth INF = inflation Rate U_t = unemployment rate $\propto_i$ = model Parameters

2- Correlation matrix:

From the correlation matrix table, no (1), we note that the degree of correlation between the inflation, unemployment rates and real economic growth, respectively reached (0.64, 0.52, 0.82).

Table (1): Correlation matrix.

	RGDP	UT	INF
RGDP	1.000000	-0.518949	-0.642914
U_t	-0.518949	1.000000	0.818478
INF	-0.642914	0.818478	1.000000

Source: from the Study data and Eviews10

3- Spread form:

From the spread figures no (4) and no (5) below, the preliminary results indicate that the relationship between the explanatory variables and the dependent variable is non-linear.

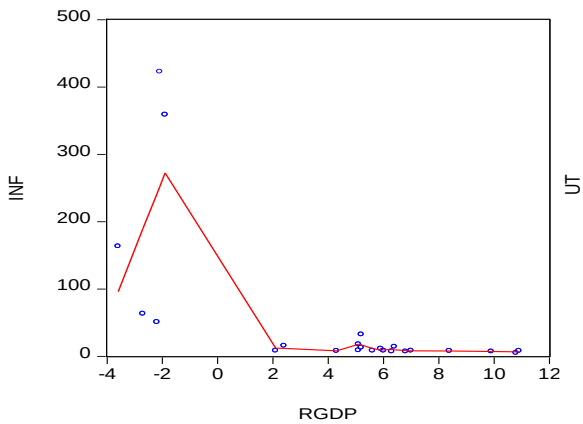


Figure (4): The shape of the spread

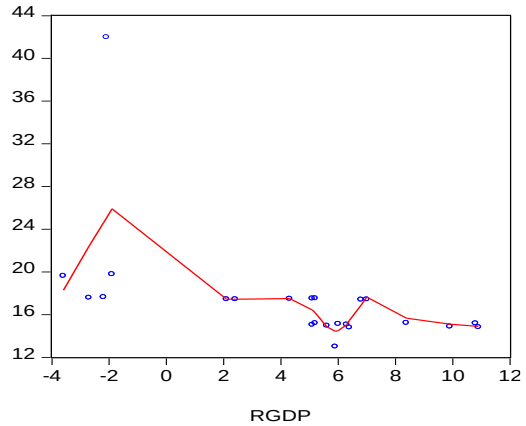


Figure (5): The shape of the spread.

4- Stationary tests:

The results of the unit root tests for the model variables revealed that the time series was stationary at the level and first difference, as table (2) shows. This is consistent with the conditions for applying non-linear autoregressive distributed lagged model NARDL.

Table (2): Results of unit root tests.

PP			ADF			variables
decision	First diff	level	decision	First diff	level	
1(1)	-5.391	-1.242	1(1)	-5.130	-1.345	RGDP
1(0)	-2.211	3.527	1(0)	5.332	7.417	INF
1(1)	-3.911	-1.627	1(1)	-3.907	2.055	Ut
critical value at 5%: ADF=-2.976, pp = -2.976						

Source: from the Study data and Eviews10

5- Rank test:

To estimate the nonlinear autoregressive distributed lagged model (NARDL), the values of the study variables were distributed into positive and negative values, and then the ranks were determined. The test was conducted by choosing lagged values for the model variables, and according to the AIC standard, the NARDL (4, 2,1,1,1) model was chosen.

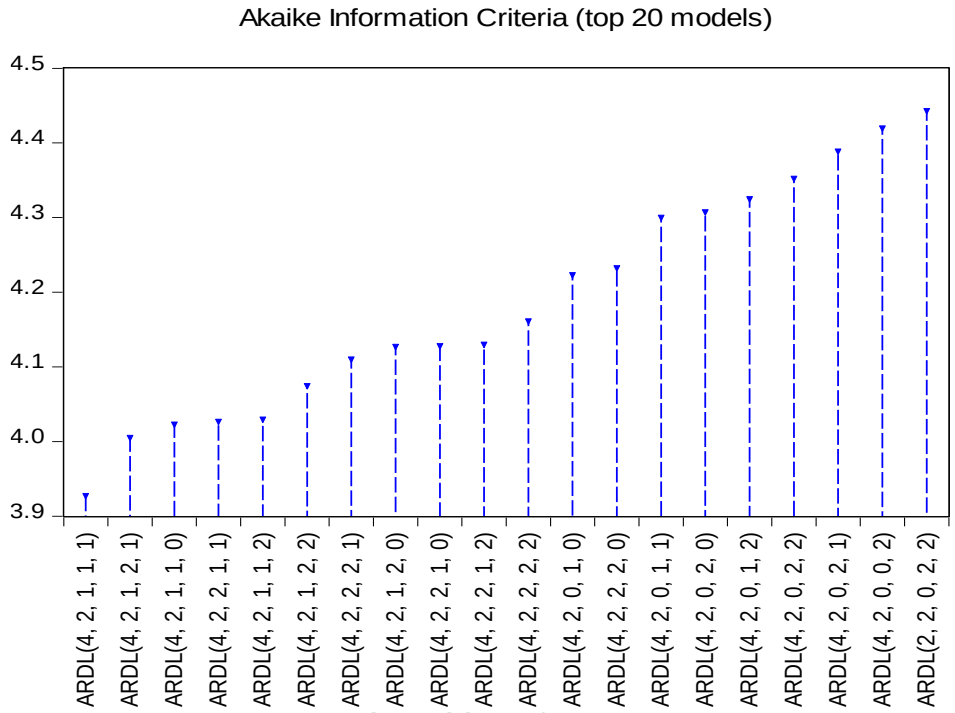


Figure (6): Rank test.

6- Cusum & Cusum if squares test:

We used (Cusum) and (Cusum if squares) tests to ensure that the study data has no structural shifts, and that there are no sudden jumps or changes over time, it was proven that the calculated values fall within the critical limits at the 5% level of significance, as in figure no (7) and (8), which means that there is stability and homogenous between the short and long-rum results.

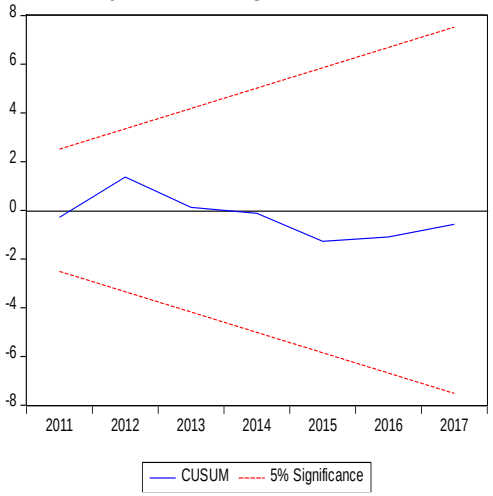


Figure (7): Cusum test.

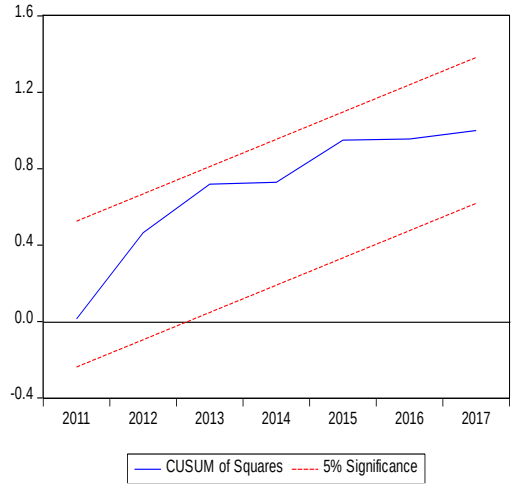


Figure (8): Cusum if squares test.

7- Cointegration test:

Table no (3) shows the results of Bound test to determine the long-run Cointegration relationship between the variables of the study. The calculated value of the F-statistics was (5.760253), which is greater than the value of the critical limits at a significance level of 5%, which means accepting the alternative hypothesis that: there is cointegration relationship between these variables.

Table (3): F-Bound test.

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.760253	10%	2.2	3.09
K	4	5%	2.56	3.49
-	-	2.5%	2.88	3.87
-	-	1%	3.29	4.37

Source: from the Study data and Eviews10

8- NARDL model estimation:

From table no (4), the values of the long-run coefficients were obtained that determine the impact of both dynamics of inflation and unemployment rates on real economic growth, and the results of the NARDL model confirmed the significance of both constant, coefficient of increase in inflation rate and unemployment rate, where an increase in inflation rate by 1% can leads to a reduction in the real economic growth by -0.15, and this result is consistent with the study's hypothesis, while a decrease in inflation rate inversely affects the real economic growth, which means that the real economic growth is inflexible to a decrease in inflation rate, while an increase in unemployment rate by 1% leads to a decrease in the real economic growth by -0.52, and this is consistent with the study's hypothesis. While a decrease in the unemployment rate leads to a positive effect on the real economic growth by 0.37, statistically it is not significant. Then the long-run equation becomes as follows:

EC = RGDP-(-0.1497*INF_POS-0.1963*INF_NEG-0.5179*Ut_POS+0.3658*Ut_NEG+6.8864).

Table (4): Long-run estimation results.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
INF_POS	-0.149654	0.049109	-3.047400	0.0285
INF_NEG	-0.196348	0.112737	-1.741644	0.1420
UT_POS	-0.517947	0.187013	-2.769586	0.0394
UT_NEG	0.365770	0.534984	0.683703	0.5246
C	6.886411	0.390502	17.63475	0.0000

Source: from the Study data and Eviews10

9- Error correction model:

The error correction model (ECM) was estimated from the results of the nonlinear autoregressive distributed lagged model(NARDL), and the value of the error correction coefficient was (-3.27) with a probability degree of (0.0004) as in table no (5), and since the value of the error correction coefficient is negative and reliable Statistically at a significance level of 5%, this means that there is a balanced relationship in the long-run, and that any imbalance in the short-run will be corrected within approximately three months.

Table (5): Results of estimating the error correction model.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(RGDP(-1))	2.100823	0.264147	7.953248	0.0005
D(RGDP(-2))	1.056795	0.229828	4.598191	0.0058
D(RGDP(-3))	0.948917	0.162181	5.850991	0.0021
D(INF_POS)	-0.010086	0.011197	-0.900772	0.4090
D(INF_POS(-1))	0.567272	0.060181	9.426044	0.0002
D(INF_NEG)	-0.089125	0.098738	-0.902634	0.4081
D(UT_POS)	1.714793	0.358905	4.777850	0.0050
D(UT_NEG)	-0.603135	0.726412	-0.830294	0.4442
CointEq(-1)*	-3.268542	0.393136	-8.314026	0.0004

Source: from the Study data and Eviews10

10- Diagnostic tests:

We used diagnostic tests to examine the estimation results of NARDL model parameters as follows:

Wald Test: Equation: NARDL

It used to test the existence of asymmetric relationship between the model variables, the probability values of the F-statistics at the level of 5% reached (2.984), and (prob=0.0889), which is not significant, and requires to accepting the null hypothesis (H_0): that the relationships between the inflation, unemployment rates and real economic growth are all similar in the long-run, as in table no (5).

Table (6): Wald Test.

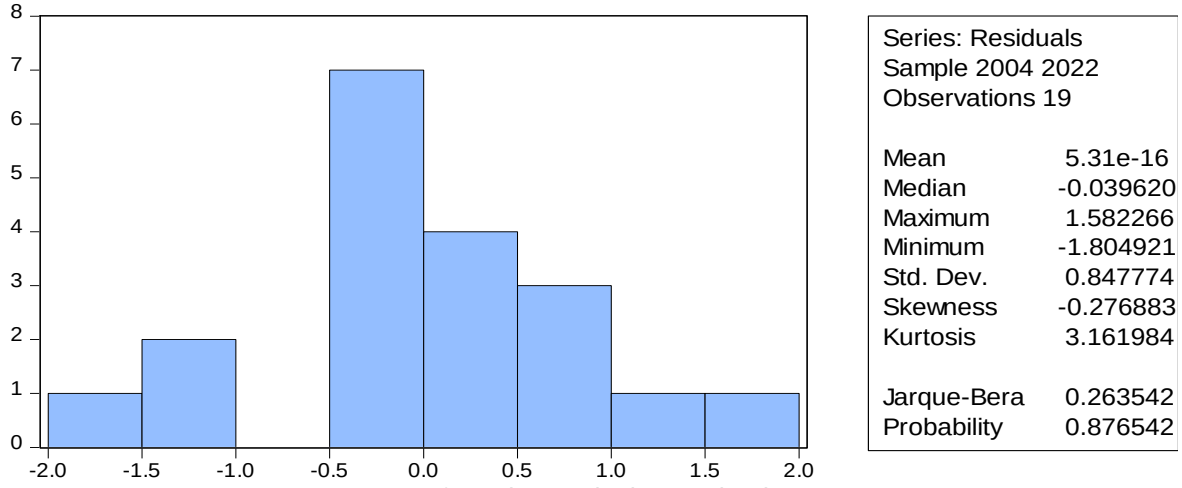
Test Statistic	Value	Probability	decision
t-statistic	-2.107351	0.0889	-
F-statistic	4.440929	0.0889	Accept H_0
Chi-square	4.440929	0.0351	-

Source: from the Study data and Eviews10

Testing the normal distribution of errors:

The probability value of Jarque-Bera test was shown as in table no (7) below (0.876542), which is greater than 5%, i.e., not significant, which means accepting the null hypothesis (H_0): that the random error is normally distributed.

Table (7): Jarque-Bera test results.



Source: from the Study data and Eviews10

Autocorrelation tests:

We used Breusch - Godfrey serial correlation LM test, and the probability value of the test was (0.1312), as in table no (8), is greater than 5%, and not significant, which is means accepting the null hypothesis (H_0): there is no autocorrelation between errors.

Table (8): Breusch-Godfrey Serial Correlation LM Test:

F-statistic		4.310241	Prob. F (2,3)	0.1312

Source: from the Study data and Eviews10

Heteroskedasticity Test: Breusch-Pagan-Godfrey:

The probability value of the test was reached respectively (0.7487) as in table (9), which is greater than 5%, i.e., not significant, which means accepting the null hypothesis (H_0): there is no Heteroskedasticity problem.

Table (9): Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.659204	Prob. F (13,5)	0.7487

Source: from the Study data and Eviews10.

Key Findings and Results:

The study concluded the following results:

- The existence of short and long-run of inverse equilibrium relationship between Keynesian Phillips curve dynamics and real economic growth.
- An increase in the inflation and unemployment rates by 1% leads to a decrease in real economic growth by approximately (-0.15, -0.52), while a decrease in the inflation rate by 1% leads to a decrease in the real economic growth, and this means that the real economic growth is inelastic to the decrease in the inflation rate. A decrease in the unemployment rate leads to an increase in real economic growth by (0.37), but this increasing statistically not significant.
- The imbalance is corrected by -3.27, that is, within approximately three months.
- There is inflation with economic stagnation and high unemployment, while in reality inflation should reduce the level of unemployment.

Recommendations:

- The government must choose the appropriate financial policy that works to achieve desirable rates of inflation and unemployment in order to reach a higher level of real economic growth.
- The necessity of carrying out structural reforms at the sector level with the aim of increasing employment, diversifying exports and reducing imports to reduce imported inflation.
- Limiting measures that increase costs, raise prices, and reduce demand, which leads to reducing the rate of stagflation.

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