Journal of Applied Science, Engineering, Technology, and Education *ISSN: 2685-0591 (online)*
Vol. 7 No. 1 (2025)
https://doi.org/10.35877/454RI.asci4206

ARDL-Based Investigation of the Relationship between Monetary Policy and Inflation Mitigation

Hassan Ali Osman Fatur[a,*], Abdalla bin Mubarak Dawwas[b], Abdelgalal Osman Idris Abaker[b], & Sami Elsir Ahmed Mohamed[b]

[a]*Department of Economic, Faculty of Economic and Commercial Studies, University of Nyala, Sudan*
[b]*Department of Adminstration Science, Applied College, Khamis Mushait, King Khalid University, Saudi Arabia*

Abstract

This study aims to estimate the efficiency of monetary policy in reducing inflation rates in Sudan for the years 2000 - 2022. The data of the study were collected from the Central Bank of Sudan and the Central Bureau of Statistics. To estimate the relationship between the variables, the study used statistical methods and econometric tools, including co integration error correction, and the Augmented Dickey-Fuller test. According to the results, there is a cointegration connection between the variables, and the variables are first order integrated. It was concluded that the estimated model is significant, and therefore it can be used to forecast, and that inflation is inversely related to both the exchange rate and the cost of financing, while the inflation is directly related to both bank credit and the money supply. To control inflation and stabilize exchange rates, a contractionary monetary policy was recommended.

Keywords: Auto-regressive Model; Inflation; Monetary policy.

Received: 15 February 2025 Revised: 29 March 2025 Accepted: 15 April 2025

1. Introduction

Inflation would be the most critical economic challenge facing many countries and many developing ones like Sudan. Inflation in Sudan has been present since the early 2000s in different levels, driven by a mix of internal agendas, external factors and socioeconomic events. This knowledge holds the key for designing sensible monetary strategies to Put an end to inflation. This study seeks to quantify the extent of influence of the different monetary policy measures on inflation levels in Sudan during the years 2000–2022 using the Auto-Regressive Distributed Lag (ARDL) model.

Monetary policy is fundamental in stabilizing prices and preventing prices from inappropriately stifling economic growth and is conducted mainly by central banks. For instance, in the case of Sudan, the Central Bank has taken several measures, such as changes in interest rates and variations in reserve requirements in an attempt to mitigate inflation (El-Ashker et al. 2021; Khamis 2020). Yet inflation has stayed stubbornly high, prompting some skepticism about whether those monetary levers are fit for purpose.

The robust dynamic analysis of the association of monetary policy variables with inflation over time can be assessed by using the ARDL model suggested by Pesaran, (Shin and Smith, 2001). The ARDL method is an improvement over co-integration techniques in that it provides for short-term and long-term inferences, which is why it has been employed in this research. Using the ARDL model, this research seeks to uncover the definitive linkages between monetary policy and inflation rates among other macroeconomic variables in the specific case of Sudan.

There is some literature on monetary policy in Sudan, but further empirical investigation into the economic mechanisms behind the efficiency of monetary policy in the country is essential. Research has shown that monetary depreciation, financial deficits, and commodity price shocks, are drivers of high inflation in Sudan (Ahmed et al., 2018; Hassan & Shafik, 2019). In addition, managing inflation during a time of socio-political instability has often created rising tensions, making the role of monetary policy in stabilizing economies even more complex (World Bank, 2022).

* Corresponding author.
E-mail address: aoadrees@kku.edu.sa

The study will also shed light on how beneficial monetary policy measures have been in fighting inflation in Sudan, it seeks to prove to what extent central bank intervention was ultimately successful or not in reducing inflation during uncertainty. Data up to 2022 will drive the findings and lead to vital insights for policymakers and stakeholders to form better strategies for price stability and economic growth.

To sum up, the study of this model can provide an essential guide to economic policies for lawmakers and continue one of the methods to reduce inflation in Sudan. This research article strives to add value by investigating this important subject matter and set a ground for future research in the relevant area.

2. The theoretical framework of the study and previous studies

2.1. The concept of inflation

Inflation is prices hike due to a rise in money flow or an increase in bank credit, i.e., an increase in money supply is faster than the rate of production growth (Abdullah, 1999). It can also be defined as prices hike of consumer commodities. From a consumer's point of view, this definition is one of the simplest one. Inflation may accompany full employment, as unemployment decreases, so prices rise as fewer persons are employed (Suleiman, 1987). Others see inflation as an increase in the general level of prices in a country (Al-Wazni and Al-Rifai, 2004). This study defines it as a continuous, self-increasing rise in prices due to an excess in aggregate demand or deficit in aggregate supply, resulting in a continuous decline in the value of the local currency.

There are three main reasons for inflation:

a. The theory of inflation by attracting demand: Economists believe that inflation resulting from attracting demand takes the form of a vicious circle. This starts with an increase in surplus monetary demand, which leads to a decrease in supply versus demand. This encourages productive projects to increase production (supply), wages, demand, and so on. (Production increases, wages increase, consumption increases, demand increases). Thus, the national economy enters a vicious circle of continuous price increases (Hussein, 2002).

b. The theory of inflation by paying alimony: Increasing prices lead to an increase in products' costs, which prompts producers to raise prices. Since expenses essentially increase the price (Hossam et al., 2005), the term payment of expenses was appropriate.

c. Structural inflation theory: Developing societies suffer from this kind of inflation, due to the structural changes in national economies, which also cause changes in aggregate demand and aggregate supply. Inflation can also be caused by economic blockades against a country, such as the blockades against Iraq, Korea, Iran and Sudan. As a result, inflation rates rise when imports and exports are blocked entirely.

2.2. The concept of monetary policy

It is a set of decisions and procedures used by central banks to influence the money supply for the purpose of achieving economic objectives (Mandour, 2004). Shamiyah, 1993, defines it as the set of actions taken by the monetary authority in society to influence credit so as to fulfill the government's economic aims.

The theoretical relationship between the variables:

a. The relation between inflation and the exchange rate: A soaring inflation decreases the value of the currency in the exchange market, while a recession increases its value (Safi, 2018).

b. The relationship between inflation and money supply: A surplus of demand exceeded current production capacity, resulting in an inflationary gap, according to Keynes. According to the Chicago School, led by Friedman, inflation is a purely monetary phenomenon caused by money growing faster than production (Sumaya, 2017).

c. The relationship between inflation and the cost of financing: Increasing the cost of financing will cause both liquidity and consumption to decrease when inflation rises. A rise in financing costs also pushes banks to use high interest rates as an investment tool to transfer liquidity.

d. The relation between inflation and bank financing: Inflation has a positive effect on commercial banks' credit. Due to inflation, the central bank reduces interest rates, which increases the demand for bank loans (Naji et al., 2019).

2.3. Inflation in Sudan during the study period

In the years 2000, 2002, 2003, 2006, 2007, the country experienced economic stability, with inflation taking the following rates, respectively: 7.8, 6.9, 6.2, 7.2, 6.2. This was a result of oil extraction, which improved macroeconomic indicators. Accordingly, the inflation rate fluctuated from 14.3% in the year 2008 to 11.2% in the year 2010, to 18.1% in the year 2011 because of a number of economic and political factors. A major factor is the world economic crisis in 2008, and the increase in government spending to meet the Comprehensive Peace Agreement's entitlements. From 2012 to 2022, inflation rates generally increased, from 35.6% in 2012 to 63.29% in 2018, then to 366.8% in 2022, (Sudan Central Bank, 2022).

2.4. Previous studies

Abdelrahman and Elhaj (2021), discussed the effect of various monetary policy tools on the dynamics of inflation in Sudan using the ARDL model. It was found that monetary policy was positively correlated with inflation rates in Sudan over the long run, suggesting that monetary policy should be managed effectively in order to stabilize inflation.

Hassan and Amani (2020), examined the mechanisms of monetary policy on inflation in Sudan using the ARDL framework. Their study found that changes in the central bank's interest rate had an important impact on inflation rates, with the effects being more pronounced over time. They emphasize the importance of effective communication and monetary policy implementation.

Mohamed (2019), used the ARDL model to examine the structural effects of monetary policy on inflation in Sudan. According to the research, inflation responses to monetary shocks are delayed, suggesting policy actions may take time to affect inflation dynamics. As a result of the findings, policymakers must anticipate the consequences of their decisions a long time after they are made.

Abdu and Salih (2022), evaluated the role of an inflation-targeting framework in Sudan's economy using the ARDL model. It has been shown that a clear inflation target set by the central bank improves credibility of monetary policy and reduces volatility of inflation. Their recommendation was to use ARDL models actively to evaluate such frameworks in Sudan.

Ibrahim (2020), conducted a comparative analysis of monetary policy's effectiveness in controlling inflation in several African countries. ARDL methodology was used to determine that while Sudan's inflation pattern resembled those of other nations, its unique economic and political context necessitated tailor-made policies for containing inflation.

Al-Hassan (2017), factors affecting inflation in Sudan during (1980 - 2015). The study aimed to determine inflation factors in Sudan. In creating the model and analyzing the data, the study used a descriptive and analytic statistical approach. Data were obtained from the Central Bank of Sudan. Using the error correction method, the model was estimated long- and short-term. Inflation rates are statistically significantly correlated with money supply, gross domestic product, exchange rate, and government spending, according to the study. In addition, inflation and its factors have long- and short-term relationships. Controlling the parallel exchange rate was recommended to achieve market balance.

Hassan (2010), determinants of inflation in the GCC countries for (1980-2007). This study examined the factors affecting inflation in Gulf Cooperation Council countries. The inflation function was studied using the co-integration method, which includes a long- and short-run error correction model, variance loading, and instantaneous response function. As a result of the co-integration method, the economic variables included in the inflation equation have a complimentary in the long run. Based on the error correction model, oil prices, the money supply rate, and global inflation are the most important economic variables affecting inflation in the GCC countries.

Ibrahim (2008), the role of the Central Bank of Sudan in managing liquidity from 1990 to 2004): This study examined how the Central Bank of Sudan manages liquidity through monetary and financing policy tools to achieve economic goals and evaluates their efficiency. The study concluded that government financing increased monetary supply, resulting in higher inflation rates. The study recommended developing other payment methods, as well as developing open market operations and including financial institutions in monetary surveys.

Comparison between the current study and previous studies:

It is worth noting that the study benefited from previous studies in formulating and building the form and the methods of analysis and measurement, and the most important thing that distinguishes it from previous studies is different in the time period and the choice of variables according to the availability of data.

3. Methodological framework of the study

In many countries, such as Sudan, inflation rates are rising. Economic policies are used to stabilize and improve those countries' economies, but Sudan's inflation rates are still constantly rising. Therefore, the study attempts to answer this question: Is inflation increasing in Sudan due to monetary factors?

The study intends to fulfill the following goals: Explaining inflation and the monetary policy factors that affect it most, Examining the relation between inflation and the significant monetary policy factors as well as their effectiveness, Identifying the most effective monetary policy factors that reduced Sudan's inflation rate and develop an econometric model for Sudan's most important monetary variables.

According to the study, the following hypotheses can be tested:

- There exists a statistically significant relation between the exchange rate and inflation.
- One can find a statistically significant relation between money supply and inflation.
- There will be a statistically significant relation between the cost of financing and inflation.
- There exists a statistically significant relation between bank credit and inflation.

In order to solve the study's problem and achieve its objectives, a hypothetical model was developed, which is presented below in the mathematical equation. It includes the exchange rate, money supply, financing costs, bank credit, and inflation.

$$INF = \alpha - \beta_1 ER + \beta_2 MS - \beta_3 FC + \beta_4 BC + U_i$$

where:

INF: Inflation (dependent variable),
ER: Exchange Rate,
MS: Money Supply,
FC: Finance cost,
BC: bank credit are independent variables,
α: The constant term of the function,
$\beta, \beta_1, \beta_2, \beta_3, \beta_4$: Are regression coefficients,
U_i: random variable.

According to economic theory and literature related to inflation, the exchange rate has an inverse relationship to inflation and thus its coefficient is negative, and the money supply is directly related to inflation, which means the coefficients will be positive in practical reality, and the cost of financing will also have an inverse relationship to inflation, so the coefficients will have a negative sign. Bank credit exhibits a positive correlation with inflation, so its coefficients will have a positive sign.

To present the study's theoretical concepts and diagnose its problem, the research employed the descriptive analytical methodology. To analyze the study data, test its hypotheses, ensure their validity, and measure the efficiency of monetary policy in reducing inflation rates in Sudan, the study used a statistical approach based on econometric tools, specifically the Auto-regressive Distributed Lag (ARDL) model.

This paper covers inflation in Sudan Republic during the period (2000 to 2022) and data are obtained mostly from secondary sources, such as books, magazines, publications, articles, scientific papers, reports of international organizations, and reports of governmental institutions.

4. Analysis methodology and results of estimating the model

4.1. Identification the model

This model includes several economic variables considered as mathematical functions to assess how monetary policy affects inflation in Sudan from 2000 to 2022.The dependent variable is inflation (INF). Exchange rate (RE), money supply (MS), financing cost (FC), bank credit (BC) are independent variables.

4.2. The model's mathematical shape and methods of analysis

This research utilised the Auto-aggressive Distributed Lag Model (ARDL) as proposed by (Pesaran and Shin, 2001), The (ARDL) Model is utilised when the dependent variable is influenced by variations in the explanatory variable as well as by its lagged values, integrating the principles of the Auto-regressive Model. The impact of the explanatory variable will be observed in both the current period (t) and several preceding periods (t - r).

The ARDL model is represented by the following equation:

$$y_t = \beta + \beta_0 x_t + \beta_1 x_{t-1} + u_t \quad (1)$$

The dependent variable's dynamic behaviour can be articulated regarding prior values (y_t). Thus, the dependent variable can be used as an explanatory variable for previous periods (y_{t-i}). The following formula represents this as an auto regressive model:

$$y_t = \lambda_1 y_{t-1} + \lambda_2 y_{t-2} + \ldots . + \lambda_p y_{t-p} + u_t \quad (2)$$

Concerning equation (1) above, the ARDL model on the right side comprises a time-lagged explanatory variable (x_{t-1})) plus the dependent variable itself comprises prior values (y_{t-i}),), Consequently, the following equation is derived:

$$y_t = \alpha + \alpha_1 y_{t-1} + \beta_0 x_t + \beta_1 x_{t-1} + u_t \quad (3)$$

Where (x,y) represent variables that are stationary at degree zero, one, or both. This test examines the possibility of existing (co-integration) between studied variables using the (ARDL) model, whether they are stationary at zero or at one degree or both. As a result of the Bound Test approach, F tests (F-statistics) are lower and upper limits based on the null hypothesis (H0), indicating that if the calculated F is less than the critical values, there is no possibility of co-integration between the model variables in the long run. As a result of accepting the alternative hypothesis, there is co-integration. As described above, error correction models are developed and limits are tested after the degree of accuracy for the studied variables has been determined. The below formula is applied:

$$\Delta y_t = a_0 + \sum_{i=0}^{r} a_{1i} \Delta y_{t-1} + \sum_{i=0}^{r} a_{2i} \Delta p_{t-i} + \sum_{i=0}^{r} a_{3i} \Delta m_{t-i} + \beta_1 y_{t-1} + \beta_2 p_{t-1} + \beta_3 m_{t-1} + \varepsilon t \quad (4)$$

Where: Δ is the first difference of the values, a_0 is the constant term, r is the number of the most suitable time lag period, a_{1i}, a_{2i}, a_{3i} = short-term coefficients. $\beta_1, \beta_2, \beta_3$=long time coefficients, t is the time and ε_t is the error.

Then if the variables are co integrated, we will estimate the short-term relationship using the model as below:

$$\Delta y_t = a_0 + \sum_{i=0}^{r} a_{1i} \Delta y_{t-1} + \sum_{i=0}^{r} a_{2i} \Delta p_{t-i} + \sum_{i=0}^{r} a_{3i} \Delta m_{t-i} + y ECT_{t-1} + \varepsilon t \quad (5)$$

Where (ECT) is the model's added error correction term and (y) is the corrected percentage of divergence from period (t-1 to period t). This refers to how quickly the dependent variable's value is transformed from its short-term towards its long-term. This model produces non-biased and efficient estimators in addition to helping to eliminate auto correlation problems and problems associated with deleting variables.

Moreover, the study depended on the (ARDL) methodology as it is appropriate for the size of observations used (23 observations).

Therefore, the final model estimation formula is as follows:

$$INF = \beta_0 + \beta_1 ER + \beta_2 MS + \beta_3 FC + \beta_4 BC + u_i, \beta_0, \beta_2, \beta_4 > 0 \ , \ \beta_1, \beta_3 < 0 \quad (6)$$

4.3. Estimating the model

The practical use of the ARDL method involves three steps: first, finding out how the variables are related by using unit root tests; second, checking if there is a relationship between them with the Bounds Testing Approach; and finally, estimating the model to get the coefficients.

4.3.1. Testing the stationarity of the data of time series

Unit root tests are employed to analyse the characteristics of time series for all variables in a model during the study, ascertain their stationarity, and identify the integration order of each variable individually.

Stationery is a fundamental condition for good and logical results in time series analysis. In this study, the Augmented Dicky Fuller (ADF) test will be used.

Regarding the (ADF) test (Table 1), the variables (inflation and financing cost) are stationary at 5% significance, indicating that they are integrated at degree (zero) (0)I.

Table 1. The findings of the unit root test within the period (2000 - 2022)

Variables	Level		First difference	
	Test value (ADF)	P-value	Test value ADF)	P-value
1. Inflation	-4.630	0.0300		
2. Exchange rate	2.012	0.9996	-3.141	0.0378
3. Money supply	2.497	0.9999	-3.597	0.0150
4. Financing cost	-4.084	0.0050		
5. The volume of bank credit	-0.828	0.787	-5.725	0.010

Having found that the variables (exchange rate, money supply, bank credit) are not stationary at the level, the unit root tests were re-conducted, and at a significance level of 5%, the results showed that the variables are stationary after the first differences. Accordingly, the time series for these variables is first-order integrated, (1)I. It is considered to be a positive sign of the effect of adopting the co integration test among time series.

4.3.2. Choosing the best lag period for the differences

In light of the fact that the ARDL model is very precise to time factors, the optimal lag period will be determined using an auto-regressive model with an unrestricted vector based on five different criteria. These criteria include: Final prediction error (FPE), Akaike Information (AIC), Schwarz (SC), Hanan Quinn (Q-H) and Maximum likelihood Ratio (LR).

A lag period that has the lowest value and establishes the most agreement is chosen as the optimal lag period.

Table 2. The criteria for choosing the best lag period

Lag Periods	LR	FPE	AIC	SC	Q-H
0	8.986939	9.036043	8.957313	26.61757	NA
1	6.622530*	6.868046*	6.474398*	2.226119*	22.39057*
2	6.824748	7.16847	6.617362	2.575575	1.089925
3	6.830052	7.271981	6.563414	2.452808	8.518129

According to Table 2, the maximum number of lag periods, as determined by all the standards, is one lag period, which is used to estimate the study example.

4.3.3. Bounds Testing Approach

Using co-integration, one can determine the long-run equilibrium relation among variables. Because the unit root tests indicated that some variables are integrated with order ((0)I) and others with order ((1)I), the (Bounds Testing) methodology Approach is considered suitable to test the extent to which co-integration between these variables is achieved within the (ARDL) model. In this test the (F) statistic is calculated to test the null hypothesis (H_0: $B_i = 0$), there is no co-integration versus the alternative hypothesis (H_1: $B_i \neq 0$), there is co-integration. There are two critical values for the F test, the first is the lower limit value, which presumes that all variables are stationary at their original values, or integrated of order zero ((0)I). Secondly, we have the upper limit, which presumes all variables are stationary at their first difference, and therefore it's an integral of order one ((1)I). A value of (F) that falls between the upper and lower limits will make the results inconclusive, which means that a decision cannot be made regarding co-integration between the variables. A bounds test was conducted to verify whether there is a long-term complementary relation among the variables, and the results are shown in Table 3.

Table 3. Bounds test for co-integration between the variables

F (19.939)	K (4)	Value
I(1) Bound	I(0) Bound	Sign.
3.1	2.2	10%
3.5	2.55	5%
3.87	2.88	2.50%
4.37	3.29	1%

By examining the F statistic value, we find it equal to (19.939), which is greater than the upper limit of critical value at the 5% level of significance (3.5). According to the decision-making rule, the null hypothesis is rejected, and the alternative hypothesis is accepted that there is co-integration and a long-term equilibrium relationship between the independent variables and the dependent variable.

4.3.4. Outcomes of measuring the model

After evaluating the stability test results and ensuring that there is an equilibrium relationship between the dependent variable and the independent variables over the long term, the ARDL model is estimated for long and short runs and the error correction vector parameter (ECM) using the equation previously discussed and based on lag periods. Based on the model estimates, the following tables provide the results of the long- and short-term effects of monetary policy tools on Sudanese inflation rates from 2000 to 2022.

Table 4. The results of estimating the long-term model

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
INF(-1)	0.874658	0.228570	3.826652	0.0019
ER	-1.408164	0.230570	-6.107311	0.0000
MS	0.000131	3.36E-05	3.889318	0.0016
FC	-1.101799	0.841388	-1.309502	0.2114
BC	0.000845	0.000182	4.634889	0.0004
BC(-1)	-0.001289	0.000217	-5.929290	0.0000
C	19.67058	10.75142	1.829580	0.0887

R-squared= 0.99, Adjusted R-squared=0.98, F-statistic=441.45, Prob (F-statistic) = (0.0003).

Table 5. The results of estimating the short-term model and the error correction parameter

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
D (BC)	0.000474	3.13E-05	15.15672	0.000
CointEq (-1)*	-0.03607	0.003586	-10.0588	0.000

R-squared= 0.985, Adjusted R-squared=0.984

4.3.5. Evaluating the results of the model assessment

a. Evaluation of the model regarding economic standards

The results of ARDL model estimation in Table 4 and Table 5 for both in the long and short run, shows that ARDL model estimation for both the short- and long-term shows:

- The exchange rate coefficient indicates that inflation rates are inversely affected in the long term as its value in the long term reaches (-1.40). Therefore, an increase in the exchange rate by (1%) leads to a decrease in inflation rates by (1.4%) in the long term, while the variable has no effect in the short-run.
- Finally, the money supply coefficient indicates that inflation rates are directly and significantly affected by it, as its value reached (0.0003). Therefore, increasing the money supply by 1 percent will increase inflation rates by (0.003%) in the long run, while the variable has no effect in the short term.
- In the course of time, the financing cost coefficient indicates there is no significant effect on inflation rates.
- Bank credit coefficient values indicate a direct and significant effect on inflation in different periods of time, with a long-term value of (0.0008). Therefore, increasing credit by (1%) will lead to a long-term inflation rate increase of 0.0008%, and a short-term inflation rate increase of (0.00047).
- Table 5 presents the results of the error correction model estimation. At a significance level of 5%, the error correction coefficient is negative and statistically significant. Thus, the independent variable and the dependent variable are in long-term equilibrium. Accordingly, the speed of correction from short to long term is estimated at 4%. Since the error correction factor reached (-0.036), this simply means that reaching equilibrium will take a long time.

b. Evaluating the model according to statistical criteria

In Tables 4 and Table 5, the results of the (T) test and the level of significance (P-value) shows that the variables (exchange rate, money supply, bank credit) are significant in the long run, since their probability values are less than (0.05), while the only variable that had a significant effect on the short term was bank credit.

*The equal to (0.99) in the long term and (0.98) in the short term, indicates that the independent variables (exchange rate, money supply, cost of financing, bank credit) explain (99%) of the change in the dependent variable (inflation) in the long term, while (98%) of the change in the dependent variable is explained by bank credit. While the remaining percentage is due to variables not included in the model. This result indicates that the (ARDL) model is effective at explaining how monetary policy tools can reduce inflation rates in the Sudanese economy.

c. Validating the model

It is necessary to diagnose the validity of the model before making statistical inferences. Assumptions regarding error limits, such as independence of observations and normal distribution of observations, are the most important criteria. In addition to ensuring the model parameters are structurally stable, the model's predictive ability must be tested by analyzing the response function of the dependent variable.

Validation outputs for the model are as follows:

1) Auto-correlation test results for residuals

The table below indicates the results of examining the null hypothesis that the residuals are both not independent, using the Lagrange multiplier test (Breusch-Godfrey Serial Correlation LM Test:) which shows that no statistical evidence to reject the null hypothesis is found; meaning that there is no auto-correlation for the residuals, since the level of significance reached (0.360), which is greater than 5%.

Table 6. Breusch-Godfrey Serial Correlation LM Test

F-statistic	Prob. F(2,12)	Obs*R-squared	Prob. Chi-Square (2)
0.104942	0.901	0.360982	0.834

2) Test results for variance homogeneity

The Breusch-Pagan-Godfrey test was used to ensure homogeneity of error. According to the following table, the null hypothesis cannot be rejected statistically due to the test results. As the test value is 0.72 greater than the significance level (5) %, variance heterogeneity does not exist.

Table 7. Breusch-Pagan-Godfrey test for variance homogeneity

F-statistic	0.81731	Prob. F(6,14)	0.5743
Obs*R-squared	5.44762	Prob. Chi-Square (6)	0.4878
Scaled explained SS	3.644409	Prob. Chi-Square (6)	0.7247

3) Results of test of normality for the error

Jarque-Bera tests were used to verify the normality of the distribution. According to the results, the test value was (1.443) with a probability value of (0.486), which is greater than 5% significance. which implies that the residuals are normally distributed. (Fig. 1).

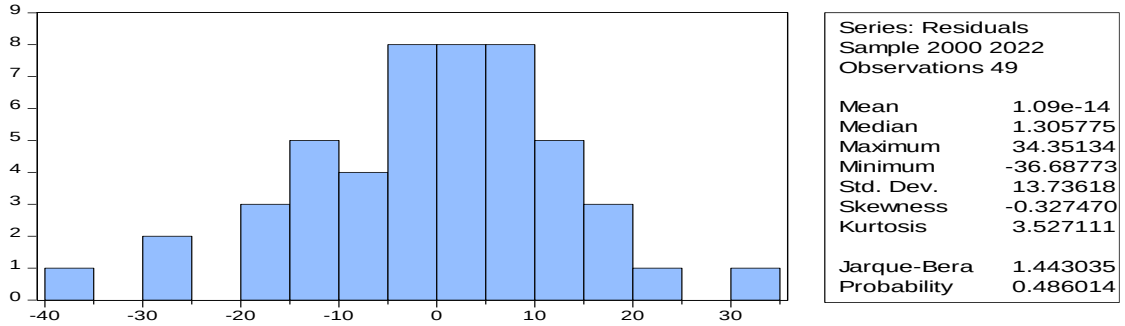

Fig. 1. Normal distribution test for the error term

4) Testing the parameters stability of the model

A Cumulative Sum of Residuals (CUSUM) test was used to verify the consistency of model coefficients in the long and short run. In order to achieve structural stability for coefficients, the graph line of the CUSUM statistic must be enclosed within the critical graph lines by (0.05). While these coefficients are unstable when it is outside. In the

measured model, it is noticed that the (CUSUM) test falls within the critical limits at a significance level (0.05), indicating that the model estimates are stable and consistent between the long and short-term, which implies that the study model's coefficients are stable throughout the time.

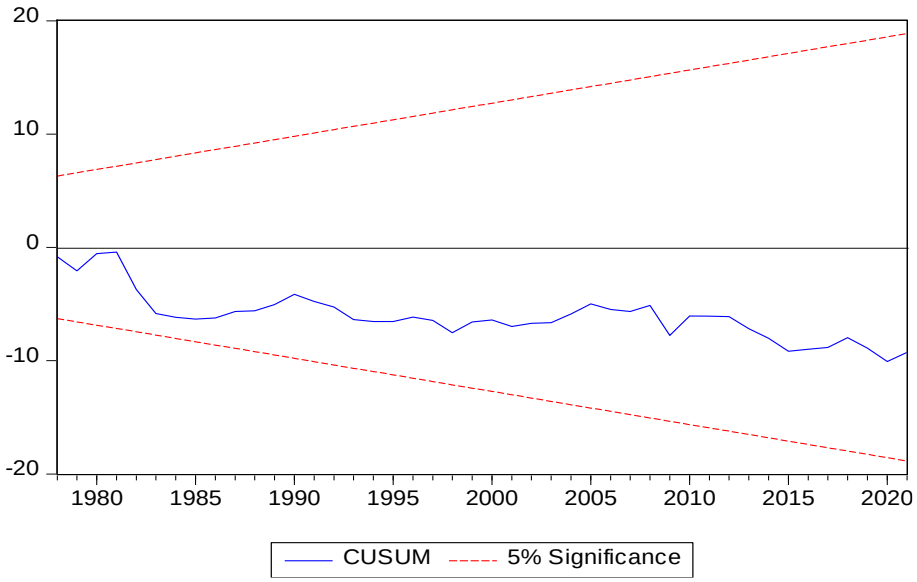

Fig. 2. The stability test of the study model

5) Testing the model's ability to predict

A test of the measured model's predictive ability can be managed by using the Theiler equality coefficient criterion, as displayed in the table below:

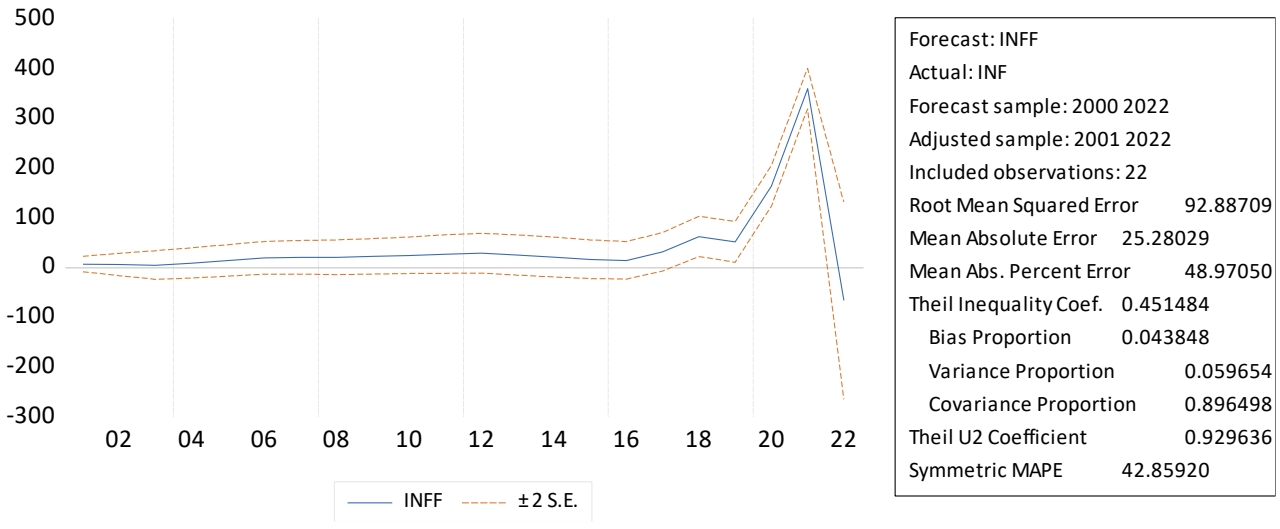

Fig. 3 Model's forecasting capability test during the period (2000 - 2022)

In Figure (8), the actual and expected inflation rate values are shown. As the Thiel coefficient reached 0.45, which is near zero, the results indicate that the estimated model is capable of predicting. Accordingly, the estimated model is able to predict internally well during the study period. It is therefore possible to rely on the results of this model to make economic analyses, policy evaluations, forecasts and decisions.

5. Conclusion and recommendations

5.1. Conclusion

According to the study, using the ARDL methodology to develop the econometric model and measure how well monetary policy reduces inflation rates in the Sudanese economy, the study found that the results were obtained:

a. The exchange rate ultimately has a significant inverse impact on inflation reaching -1.40, whereas in the short term, there is no effect.
b. As the money supply reached (0.0003), the results confirm that the variable ultimately has a direct and significant effect on inflation rates, but has no effect in the short run.
c. There is no significant effect of financing costs on inflation rates sooner or later, according to the outputs.
d. Bank credit, which is the most influential factor on inflation, has positively impacted inflation rates sooner or later, as its long-term value reached 0.0008, while its short-term value reached 0.00047.
e. Estimation of the error correction model revealed a long-term equilibrium between the independent and dependent variables. It is estimated that the speed of correction from the short term to the long term is only about 4%. Therefore, reaching equilibrium takes a long time.
f. As we find that financing cost is not significant, monetary policy did not reduce inflation rates in Sudan during the study duration. The inflation rate is only influenced by bank credit in the long and short run, whereas exchange rates and money supply only matter in the long run.
g. Independent variables account for 99% of inflation changes in the long and short runs. Therefore, the model explained well how monetary policy in Sudan reduced inflation rates during the study period.
h. A model of monetary policy's effectiveness in reducing inflation rate in Sudan shows good internal forecasting ability during the study period. As a result, its results can be used for economic decision-making.

5.2. Recommendations

The study recommends the points based on its results:

a. Use a contractionary monetary policy to maintain inflation and stabilize the deal with the rate. Other factors affecting prices are taken into account as well.
b. Controlling the money supply by controlling the monetary base, especially the public sector's entitlements to the banking system.
c. Controlling deficit financing by controlling monetary policy, which increases the money supply and increases inflation.
d. Commercial banks should be subjected to more stringent credit policy controls consistent with state economic policies.
e. When determining banks' financing costs, inflation must be taken into account, so that the mechanism achieves its goals (expanding or contracting the money supply).
f. Utilizing a rational monetary policy that considers the ongoing relation between the financial policy and inflation.
g. For the future study of inflation in Sudan, it is important to include political and legislative factors in the model when studying the factors affecting inflation.

Acknowledgement: The authors extend their appreciation to the Deanship of Scientific Research at King Khalid University for funding this work through large group Research Project under grant number RGP2/492/46.

References

Abdelrahman, M., & Elhaj, A. (2021). The Dynamics of Inflation in Sudan: An ARDL Approach. Sudanese. *Journal of Economic Studies, 18(2),* 55-78.

Abdu, S., & Salih, T. (2022). Evaluating Inflation Targeting in Sudan: An ARDL Model Approach. *International Journal of Banking and Finance, 10(3),* 147-160.

Abdullah, Aqeel Jassim (1999). Money and Banking, *Majdalani Publishing House,* Amman, Hashemite Kingdom of Jordan.

Ahmed, A. D., & Mourshed, M. (2018). Monetary policy and inflation in Sudan: An empirical analysis. *Journal of Economics and Business, 93,* 12-28.

Al-Hassan, Tamadur Jaber Al-Bashir (2017). Factors affecting inflation in Sudan during the period (1980 - 2015) *Journal of Economic Sciences* - Deanship of Scientific Research, *2(18)*, Sudan University of Science and Technology, Khartoum.

Al-Wazani, Khaled Wassef and Al-Rifai, Ahmed Hussein (2004). Principles of Macroeconomics between Theory and Practice, *Wael Publishing House*, Amman, The Hashemite Kingdom of Jordan.

Asshoff, S et al (2020). Unconventional monetary policy and inflation expectations in the Euro area, working document, No 2020/01, January 2020.

El-Ashker, M. A., Yousuf, M. H., & Badran, M. (2021). The role of monetary policy in inflation control: Evidence from Sudan. African, *Journal of Economic Review, 9(1),* 77-98.

Hassan, A., & Amani, F. (2020). Monetary Policy Transmission to Inflation in Sudan: Evidence from ARDL Model. *Middle Eastern Journal of Economics, 14(1),* 201-220.

Hassan, Hassan bin Rafdan (2010). Determinants of inflation in the Gulf Cooperation Council in the period (1980-2007), *King Fahd University*, Kingdom of Saudi Arabia.

Hassan, M. K., & Shafik, A. (2019). Understanding the inflationary pressures in Sudan: A dynamic econometric approach. Sudanese, *Journal of Economic Studies, 4(3),* 45-62.

Hussam Daoud et al (2000). Principles of Macroeconomics, Dar Al-Masara for Publishing, Distribution and Printing. Amman, *The Hashemite Kingdom of Jordan*.

Hussein bin Hani (2002). The Economics of Money and Banks (Foundations and Principles), *Dar Al-Kindi for Publishing and Distribution*, Jordan.

Ibrahim, Sawsan Al-Zubair (2008) The role of the Central Bank of Sudan in liquidity management in the period (1990 - 2004), unpublished master's thesis, *Sudan University of Science and Technology*, Khartoum.

Ibrahim, Y. (2020). Monetary Policy Effectiveness in Africa: A Comparative Study Including Sudan. *African Journal of Economic Policy, 6(2),* 120-135.

Khamis, G. M. (2020). The impact of monetary policy on inflation in Sudan: A comparative study. *Arab Journal of Business and Management Review, 3(2),* 112-130.

Mandour, Ahmed Muhammad (2004), Introduction to Macroeconomic Theory, *University House*, Egypt.

Mohamed, B. (2019). Structural Effects of Monetary Policy on Inflation in Sudan. *Journal of African Economies, 28(4),* 983-1005.

Naji, Ahmed Farid et al (2019). Factors affecting bank credit in Jordanian commercial banks for the period (2010 - 2015). *Journal of Economics of Finance and Business, 3(2),* Algeria.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics, 16(3),* 289-326.

Pesaran, M.H., Shin, Y. and Smith, R.J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics, 16,* 289-326. http://dx.doi.org/10.1002/jae.616

Safi, Muhammad Ibrahim Muhammad (2018). The most important determinants of the exchange rate in Sudan using simultaneous equation models (1980-2015), unpublished doctoral thesis, *Sudan University of Science and Technology*, Khartoum.

Shamiya, Ahmed Zuhair (1993). Money and Banking, *Zahran Publishing and Distribution House*, first edition, The Hashemite Kingdom of Jordan.

Soumaya Belkacemi (2017). The problem of the relationship between unemployment and inflation - with statistical application to the Algerian economy, unpublished doctoral thesis, *University of Batna*, Algeria

Sudan Central Bank. (2022). Annual report on monetary policy.

Suleiman, Al-Bazi Hamad (1987). The International Transmission of Inflation, *Journal of Public Administration*, First Issue, Kingdom of Saudi Arabia.

World Bank. (2022). *Sudan economic monitor*: Addressing inflationary challenges.