

The Importance of Monetary Policy Tools in Controlling Inflation Trends in Algeria During the Period 1990-2023 A Standard Study Using ARDL Models

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ABSTRACT

This study focuses on assessing the impact of monetary policy tools, specifically the legal reserve and rediscount rates, on inflation in Algeria. It aims to estimate the long-term equilibrium relationship using the Autoregressive Distributed Lag (ARDL) model methodology. The findings indicate that the rediscount rate is more effective in controlling inflationary trends in Algeria over the long term.

Introduction

It is widely accepted that money's role has evolved far beyond merely facilitating exchanges. Today, money serves as a critical indicator of societal advancement and overall well-being. In addition, its influence on numerous economic challenges, such as inflation, price increases, recessions, and depressions, is undeniable.

Given that many of these economic problems are often attributed to monetary causes, it is believed that sound monetary management can play a pivotal role in controlling, or at least alleviating, their negative impacts. For instance, by managing the money supply—through expansionary policies in times of recession or contractionary policies during economic booms—it is possible to guide the actual inflation rate toward a desired target.

This approach has been adopted by monetary authorities in Algeria, especially following the implementation of an expansionary monetary policy in April 2001. This policy coincided with both the Economic Recovery Program and the Economic Recovery Support Program for the period 2005-2009, ultimately contributing to growing inflationary pressures. Consequently, it became necessary to formulate a strategy to regulate inflation in the short term while striving for long-term price stability.

In the early 2000s, particularly between 2002 and 2010, Algeria's authorities implicitly targeted inflation within their monetary policy framework, setting an initial consumer price index target of 3% (Khalafallah, Z., & Srarma, 2016). Eventually, the objective of "price stability" was explicitly adopted as a formal goal of monetary policy through Ordinance No. 10/04 on August 26, 2010, which amended and supplemented Ordinance No. 03/11. This ordinance established an inflation target range of 4%-5% and confirmed "price stability" as a core policy aim. The commitment to price stability was further reinforced with Law No. 23/09, issued on July 21, 2023, as part of the monetary and banking law. The central bank is now formally responsible for ensuring price stability within its broader monetary

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policy objectives (Law No. 23/09, dated July 21, 2023, Article 35).

The central issue explored in this study is whether Algeria's monetary authorities can successfully achieve price stability using the currently available monetary policy tools. This leads to the main research question:

Can the monetary authorities in Algeria succeed in achieving price stability using the currently available set of tools?

To address this question, the following sub-questions are posed:

1. **What is meant by the goal of price stability, and what is its relationship with the inflation targeting strategy?**
2. **Do the monetary authorities in Algeria possess all the requirements necessary for successfully achieving price stability?**
3. **What is the nature of the long-term equilibrium relationship between monetary policy tools and the inflation rate?**
4. **How do the reserve requirement rate and the rediscount rate affect inflation in Algeria in both the short and long terms?**

Research Hypotheses:

To investigate the research questions, the study formulates the following hypotheses:

1. **Adopting an inflation targeting strategy** as a modern framework for monetary policy enables the monetary authorities in Algeria to achieve the goal of price stability in the long term.
2. **The monetary authorities in Algeria can provide all the necessary prerequisites** for implementing the inflation targeting strategy.
3. Factors hindering Algeria's monetary authorities from achieving satisfactory results through inflation targeting include **the weak responsiveness of domestic inflation to monetary policy measures**, which may stem from the limited scope of market activity.

These hypotheses aim to determine the feasibility and effectiveness of the monetary policy framework in Algeria, particularly in relation to inflation control.

1- ****Inflation Targeting Strategy as a Modern Framework for Monetary Policy Management****

1-1 Concept of Monetary Policy

Monetary policy, in conjunction with fiscal policy, forms the foundation of a nation's economic management system. Its effectiveness lies in the coordination between monetary policy—typically managed by a central bank—and fiscal policy—overseen by government bodies. Monetary policy is often defined as the actions taken by the central bank or other monetary authorities to regulate the money supply in order to achieve economic objectives.

For instance, the Bank of Algeria describes ****monetary policy**** as the set of measures aimed at controlling the money supply within the economy to fulfill its macroeconomic goals [source] . Similarly, economist J.P. Patat defines it as the central bank's efforts to control the money supply to meet broader economic policy objectives (Boudebouda, Z., & Messaoud, R., 2022).

Key Several critical elements define monetary policy:

- Measures: Decisions taken by monetary authorities to steer the strategic direction of monetary policy, such as adjusting interest rates or reserve requirements.

- Monetary Authority^{**}: The central institution, typically the central bank, responsible for managing the country's monetary policy.
- Tools: Instruments like the discount rate, open market operations, and reserve requirements used by the central bank to influence economic conditions.
- ^{**}Future Orientation^{**}: Monetary policy decisions are inherently forward-looking, aiming to address future economic outcomes rather than past events.

Objectives of Monetary Policy

Historically, central banks have pursued various monetary policy objectives, including:

- Promoting high employment and stable economic output
- Fostering economic growth
- Ensuring interest rate stability
- Stabilizing financial markets
- Maintaining stable exchange rates

In recent years, ^{**}price stability^{**} has emerged as the most important goal of monetary policy for many central banks worldwide, reflecting a shift in priorities. The rationale is that stable prices allow producers and consumers to make informed decisions, which supports long-term economic growth.

Price Stability as a Central Objective

Price stability is essential for sustainable growth. When prices fluctuate unpredictably, it becomes challenging for economic actors to plan for the future. High inflation, in particular, can erode purchasing power and destabilize economic planning, thereby hindering growth.

Price stability means that the central bank strives to keep inflation within a manageable range to avoid significant deviations that could impact future price expectations. While complete price control is unrealistic, central banks seek to maintain inflation within specific limits, allowing businesses and consumers to plan without the fear of sudden inflation spikes.

By targeting ^{**}inflation control^{**}, central banks play a crucial role in fostering economic stability, ensuring that prices rise predictably and gradually rather than erratically.

In contrast, inflation targeting involves adjusting monetary policy to achieve a specific annual inflation rate (typically around 2% or 3% per year). Central banks with this strategy aim to reach a precise annual inflation rate and are held accountable for achieving this target each year. This makes inflation targeting more rigid compared to price stability, which can be pursued over a longer timeframe.¹

Economists and central bank officials agree that the success of an inflation targeting strategy largely depends on several prerequisites, which can be categorized as follows:

Institutional Requirements:

¹ It is worth noting that monetary policy objectives can be distinguished at three levels: the operational target, the intermediate target, and the ultimate target. The ultimate target should be clearly defined and indisputable, and established with a fixed criterion. For example, if price stability is adopted as the ultimate target, one of the measures of the money supply, such as M1, M2, or M3, could serve as an intermediate target, while short-term nominal interest rates in the money market could be the operational target.

- The central bank must possess a sufficient level of independence to select the appropriate strategies and tools necessary to meet its objectives, while also being accountable if it fails to meet its responsibilities.
- Adequate monetary conditions must be established by implementing a flexible exchange rate system and advancing the development of financial markets.
- It is essential to emphasize the use of indirect monetary policy instruments instead of relying heavily on direct methods, which may hinder the policy's effectiveness in managing inflation.
- The central bank should serve as the lender of last resort, offering financial support, loans, and reliable information to the financial system when necessary.

Economic Requirements:

- There should be complete coordination between fiscal and monetary policies, ensuring that both share aligned views and objectives.
- Reducing public debt and avoiding reliance on borrowing from the banking sector is crucial.
- Efforts must be made to limit foreign liabilities in the banking system to strengthen confidence in the national currency.
- Stability in the demand for money is essential for the effectiveness of monetary policy.

Infrastructure Requirements:

- The central bank needs to be equipped with advanced computer systems, software, and forecasting models to generate accurate inflation predictions, compare them with target rates, and take corrective measures when required.

1-3: Monetary Policy Tools:

To effectively carry out its monetary and banking functions and achieve its objectives, the central bank must utilize a variety of tools. Below are some key instruments traditionally employed by central banks to reach their monetary policy goals:

(https://www.investopedia.com/terms/i/inflation_targeting.asp)

- Adjusting the Reserve Requirement Ratio**: Modifying the proportion of reserves banks are required to maintain against their deposits.
- Setting Credit Limits**: Establishing restrictions on the volume of credit that banks are allowed to extend.
- Linking Loans to Bank Capital**: Aligning the amount that banks can lend with their capital reserves.
- Linking Loans to Deposits**: Relating the volume of lending to the deposits held by banks.
- Managing Credit Volume**: Controlling both the quantity and distribution of credit within the economy.
- Modifying Interest Rates**: Adjusting rates to influence saving and borrowing behaviors in the economy.
- Moral Suasion**: Using non-coercive methods to encourage banks and financial institutions to follow certain policies or practices.
- Open Market Operations**: Buying and selling government securities to regulate the money supply.
- Foreign Exchange Market Interventions**: Engaging in currency trading to influence exchange rates.

These instruments can be categorized into two groups based on their relationship with the financial market: direct and indirect tools (Bachichi, W. 2017).

1-3-1: Direct Tools:

Often referred to as traditional tools, these methods are not directly connected to the financial markets. They serve to guide banks and enforce compliance with specific instructions issued by the monetary authorities or values set by them. These tools limit the autonomy of banks, directly affecting their money creation capabilities and decision-making processes. Examples include:

- Reserve Requirement Ratios
- Credit Limits

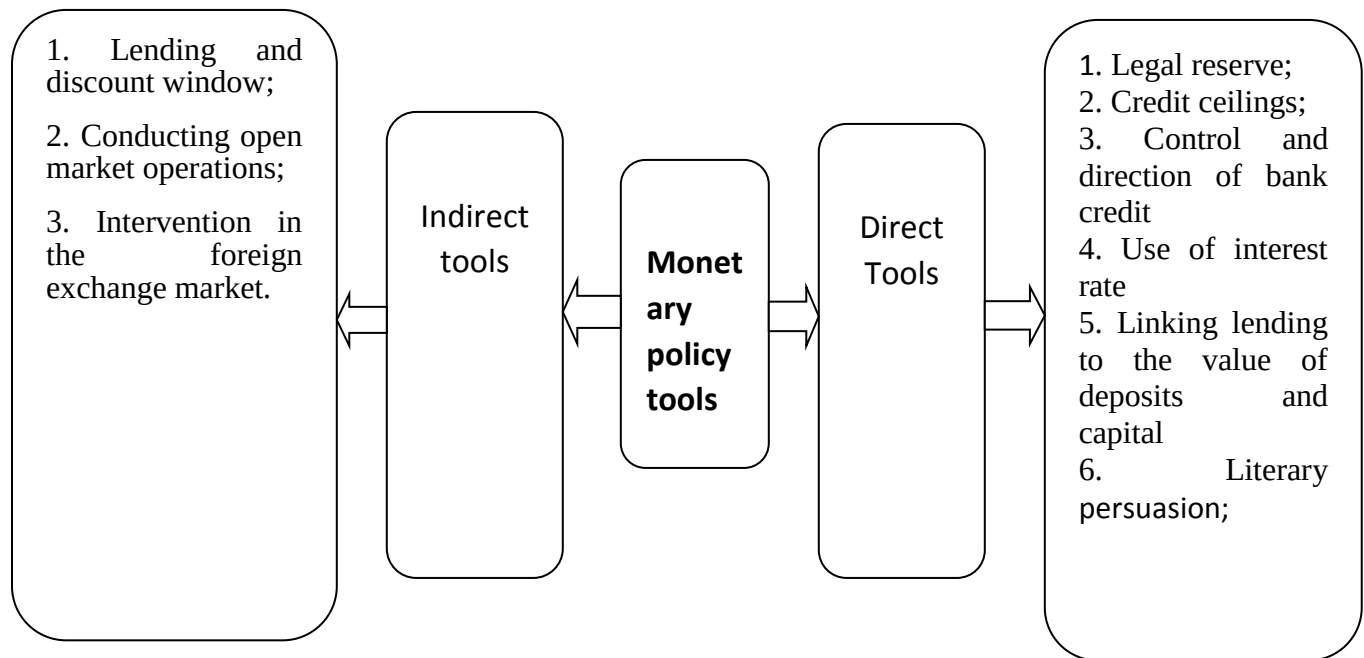
1-3-2: Indirect Tools:

As a more modern approach to monetary management, these tools operate through the financial markets. They aim to influence market indicators, which in turn shape banking behaviors, such as asset liquidity, lending costs, and investment returns. Unlike direct tools, indirect methods do not involve issuing commands but instead work by affecting broader market conditions. Examples include:

- Interest Rate Adjustments
- Open Market Operations
- Foreign Exchange Market Interventions

This classification underscores how central banks leverage both direct and indirect methods to steer economic outcomes and fulfill their monetary policy objectives.

Figure No. (1): Monetary policy tools



Source: (Mahmoud Abu Al-Ayoun, 2020)

In Algeria, the ****Bank of Algeria**** employs a variety of instruments to achieve the monetary policy goals established by the Monetary and Credit Council at the start of each fiscal year. These tools enable the central bank to intervene in the money market, overseeing interest rates and regulating banking liquidity (System No. 2009-02, dated May 26, 2009). Key tools include:

-Guidance Rate (Moyenne des Taux de Référence)**: This rate acts as a reference point for other interest rates in the economy, influencing the cost of borrowing and lending across the financial system.

-Open Market Operations**: The central bank buys or sells government securities to adjust the money supply and influence interest rates.

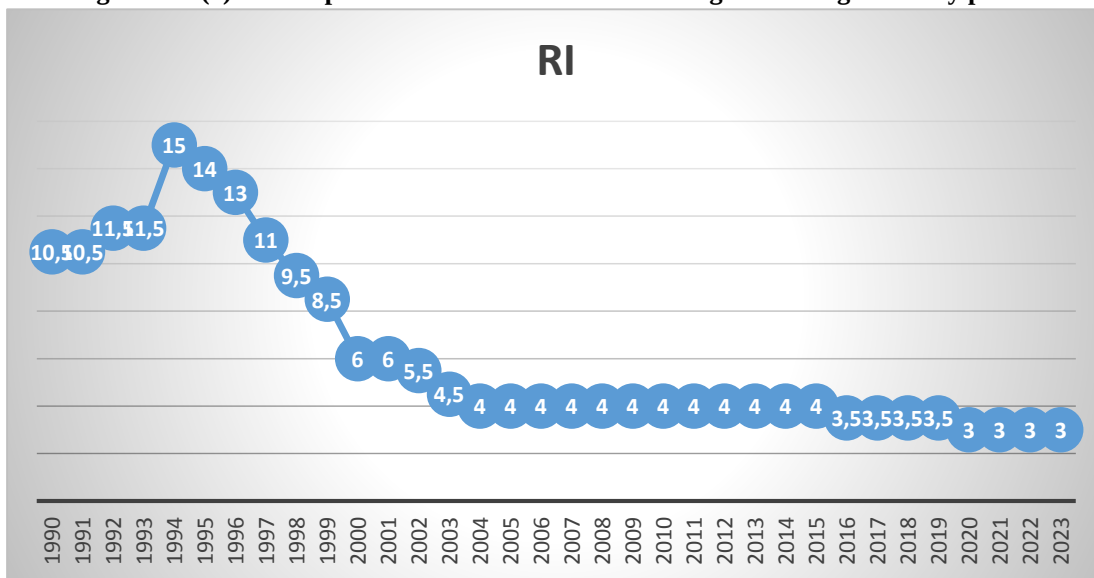
-Permanent Facilities**: These provide or absorb liquidity in the short term to manage fluctuations in the money market.

-Minimum Reserve Requirements**: This refers to the percentage of deposits that banks are required to hold as reserves with the central bank, affecting their capacity to extend loans.

-Discount and Loan Operations**: These include offering short-term loans to banks and adjusting the terms of these loans as a way to influence liquidity and the money supply.

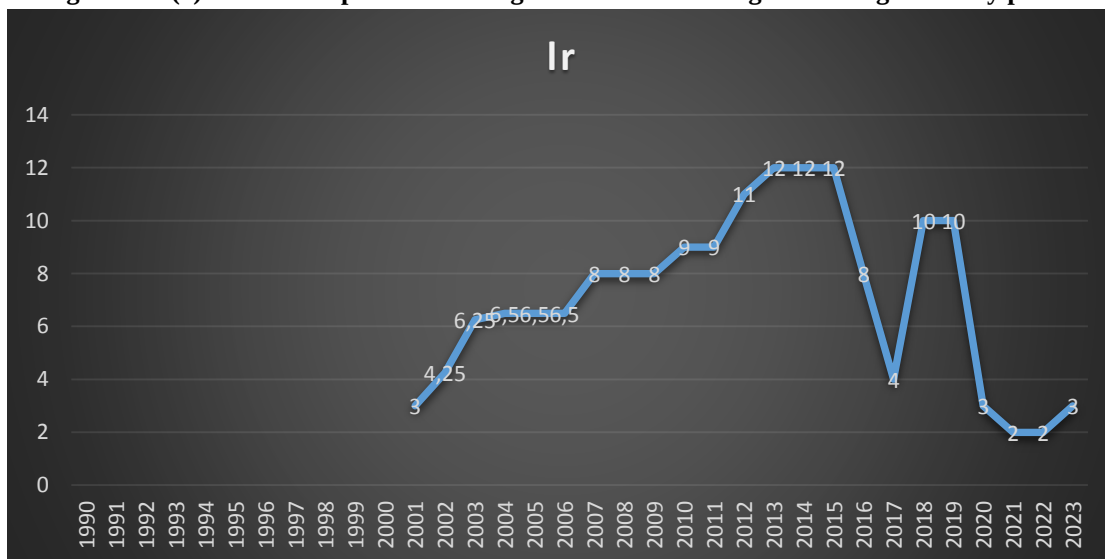
These tools are central to steering monetary policy in Algeria, ensuring effective management of interest rates and banking liquidity. The figures below illustrate the evolution of the most important monetary policy instruments used in Algeria between 1990 and 2023.

Figure No. (2): Development of the rediscount rate in Algeria during the study period



Source: Prepared by the researcher

Figure No. (3): The development of the legal reserve rate in Algeria during the study period



Source: Prepared by the researcher

2- Measuring the Impact of Monetary Policy Tools on Inflation Trends in Algeria over the Short and Long Terms

In this section, we aim to evaluate the impact of key monetary policy tools—specifically, the **discount rate (RI)** and the **legal reserve rate (LR)**—on inflation trends in Algeria, as measured by the **Consumer Price Index (INF)** from 1990 to 2023. To achieve this, we will employ **Autoregressive Distributed Lag (ARDL)** models, which allow us to analyze both short-term effects and long-term equilibrium relationships, along with the transition mechanism between these time frames using an error correction model.

The **ARDL model** is particularly suited for this analysis, as it can accommodate varying lag structures and is flexible in estimating short-term dynamics as well as long-term relationships. By utilizing this approach, we can assess how adjustments in the discount rate and reserve requirements affect inflationary patterns over both the short and long term, while also gaining insight into how the economy returns to equilibrium after deviations.

2-1: Descriptive Statistical Analysis of the Study Variables

For this analysis, data on the **discount rate (RI)** and the **legal reserve rate (LR)** were sourced from quarterly statistical bulletins and annual reports provided by the Bank of Algeria. Inflation data, represented by the annual change in the **Consumer Price Index (INF)**, was obtained from the National Statistics Office. The study period spans from 1990 to 2023 (see Appendix 1).

The descriptive statistical analysis will focus on summarizing key attributes such as central tendencies, variability, and trends, offering an initial exploration of how these variables behave over the study period. This analysis will include:

- **Mean Values**: Calculating the average discount rate, reserve rate, and inflation rate.
- **Measures of Variability**: Using standard deviation and variance to gauge the dispersion of the data.
- **Trend Analysis**: Observing the long-term patterns and shifts within the data.
- **Correlations**: Examining the relationships between the discount rate, reserve rate, and inflation to understand their interconnections.

These preliminary statistics will provide a foundational understanding of the data's basic characteristics, setting the stage for the application of ARDL models to explore the interactions and dynamics between these variables.

Table No. (01): Descriptive statistical indicators

	INF	LR	RI
Mean	4.863478	7.130435	3.913043
Median	4.200000	8.000000	4.000000
Maximum	9.700000	12.00000	6.000000
Minimum	1.800000	2.000000	3.000000
Std. Dev.	2.298131	3.278606	0.717511
Skewness	0.901339	-0.092552	1.254378
Kurtosis	2.999052	1.849954	5.078991
Jarque-Bera	3.114250	1.300334	10.17373
Probability	0.210741	0.521959	0.006177
Sum	111.8600	164.0000	90.00000
Sum Sq. Dev.	116.1909	236.4837	11.32609
Observations	23	23	23

Source: Prepared by the researcher

Descriptive Statistics of the Study Variables (1990-2023)

- Inflation Rate (INF)
- Average (Mean): 4.86%
- Range: 1.8% to 9.7%

- Variation: The inflation rate was above 4.20% for half of the years in the period.
- Coefficient of Variation: 47%
- Legal Reserve Rate (LR)
- Average (Mean): 7.13%
- Range: 2% to 12%
- Variation: The rate exceeded 8% for half of the years in the period.
- Coefficient of Variation: 45%
- Discount Rate (RI)
- Average (Mean): 3.91%
- Median: 4%
- Range: 3% to 6%
- Coefficient of Variation: 18%

These descriptive statistics provide a foundational understanding of how the discount rate, legal reserve rate, and inflation rate have behaved over the study period. This initial analysis will aid in the further exploration of the relationships and dynamics among these variables using ARDL models

.Table No. (02): Linear correlation matrix between study variables

Covariance Analysis: Ordinary Sample: 2001 2023 Included observations: 23 Balanced sample (listwise missing value deletion)			
Correlation Probability	INF	LR	RI
INF	1.000000 -----		
LR	-0.168647 0.4418	1.000000 -----	
RI	-0.388213 0.0672	0.072669 0.7418	1.000000 -----

Source: Prepared by the researcher using EViews program

Statistical Analysis of the Relationship Between Variables

-Legal Reserve Rate (LR) and Inflation Rate (INF)

- **Correlation:** The analysis did not reveal a statistically significant linear relationship between the legal reserve rate and the inflation rate in Algeria.

-**Discount Rate (RI) and Inflation Rate (INF)**

- Correlation: A statistically significant negative linear correlation was identified between the discount rate and the inflation rate, with significance at the 10% level. The correlation coefficient was calculated at -0.388.

These results indicate that while the legal reserve rate does not have a notable direct effect on inflation, the discount rate shows an inverse relationship with inflation. Specifically, higher discount rates appear to be associated with lower inflation. This relationship will be further explored through the ARDL model to better understand both its short-term and long-term effects.

2-2: Unit Root Tests

To apply ARDL models in analyzing the relationship between monetary policy tools and inflation in Algeria and in determining the presence of a long-term equilibrium relationship, it is necessary that the dependent variable's time series is integrated of order 1. Meanwhile, the independent variables' time series should not exceed this order of integration. Moreover, an adequate number of data points is required to ensure sufficient degrees of freedom for estimating inflation (INF) in relation to the discount rate (RI) and the reserve requirement (LR), including their distributed lags.

.2-2-1 Testing the stationarity of the time series of the dependent variable

Table No. (03): PP stationarity test for the inflation time series

UNIT ROOT TEST TABLE (PP)			
Null Hypothesis : INF has a unit root			
$H_0: C = 0$ (Prob)	$H_0: b = 0$ (Prob)	$H_0: \lambda = 0$ (Prob)	Forms
At Level			
0.5337	0.7779	0.7924	In the presence of the general trend coefficient and the intercept
0.3750	-	0.4074	In the presence of the intercept
-	-	0.1162	Without a threshold and without a general trend factor
At First Difference			
0.1646	0.2128	0.0001	In the presence of the general trend coefficient and the intercept
0.5307	-	0.0000	In the presence of the intercept
-	-	0.0000	Without a threshold and without a general trend factor

Source: Prepared by the researcher using EViews program

The Phillips-Perron test for the inflation time series at the original level indicates the possibility of accepting the hypothesis of a unit root in the three known specifications. However, this hypothesis is rejected after first-differencing the values of this series (where the three p-values are less than the significance level of 0.05). Therefore, it is accepted that the series is stationary at this order. This means that INF is integrated of order 1.

2-2-2 Testing the stability of the time series of the mandatory reserve ratio :

Table No. (04): PP stability test for the time series of the mandatory reserve ratio LR

UNIT ROOT TEST TABLE (PP)			
Null Hypothesis : LR has a unit root			
$H_0: C = 0$ (Prob)	$H_0: b = 0$ (Prob)	$H_0: \lambda = 0$ (Prob)	Formulas
At Level			
0.0464	0.1931	0.7649	With the presence of the general trend and secant coefficient
0.0975	-	0.3150	With a breaker
-	-	0.4214	No breaker and no general direction factor
At First Difference			
0.2916	0.2672	0.0001	With general direction factor and circuit breaker
0.9203	-	0.0015	With circuit breaker
-	-	0.0000	Without circuit breaker and without general direction factor

Source: Prepared by the researcher using EViews program

The p-values of 0.7649, 0.3150, and 0.4214 indicate the presence of a unit root when estimating the three specifications mentioned above. However, after performing first differencing, the stationary of the series for the required reserve ratio is accepted. Therefore, this series is integrated of order.

3-2-2 Testing the stationarity of the time series of the rediscount rate RI:

Table No. (05): PP stationarity test for the time series, rediscount rate

UNIT ROOT TEST TABLE (PP)			
Null Hypothesis : RI has a unit root			
$H_0: C = 0$ (Prob)	$H_0: b = 0$ (Prob)	$H_0: \lambda = 0$ (Prob)	Formulas
At Level			
			With the presence of the general trend and secant coefficient
	-		With a breaker
-	-		No breaker and no general direction factor
At First Difference			
			With general direction factor and circuit breaker
	-		With circuit breaker
-	-		Without circuit breaker and without general direction factor

Source: Prepared by the researcher using EViews program

2-3- Estimation of the ARDL Model for the Impact of Monetary Policy Tools on Inflation in Algeria

The Autoregressive Distributed Lag (ARDL) model explains the effect of monetary policy in Algeria (LR_t, RI_t) on the growth of the general price level INF_t as follows:

$$INF_t = a_0 + \sum_{i=1}^p \psi_i INF_{t-i} + \sum_{j=0}^{q_1} \alpha_j LR_{t-j} + \sum_{m=0}^{q_2} \beta_m RI_{t-m} + \varepsilon_t$$

P: Degree of slowing of price inflation;

q_1: Deceleration degree of the reserve requirement rate LR;

q_2: Degree of slowing down of the rediscount rate RI;

$\psi_i, \alpha_j, \beta_m$ Autoregressive coefficients of variables INF_{t-i}, LR_{t-j} and RI_{t-m} respectively, with respectively distributed delays p, q_1, q_2 .

Accordingly, the autoregressive model of distributed time lags for inflation in terms of monetary policy instruments in Algeria is as follows:

$$INF_t \sim ARDL(p; q_1, q_2)$$

2-3-1- Determining the optimal deceleration grades (p; q1, q2)

After comparing all possible specifications of Autoregressive Distributed Lag (ARDL) models with lags of up to 6 for both independent and dependent variables, the best lag lengths are those that result in the lowest values for the information criteria AIC, BIC, HQ, and the highest value for the adjusted R-squared.

Table No. (06): The five best estimated formulas for the ARDL model						
Model Selection Criteria Table						
Dependent Variable: INF						
Date: 05/01/24 Time: 08:06						
Sample: 1990 2023						
Included observations: 18						
Model	LogL	AIC*	BIC	HQ	Adj. R-sq	Specification
1	32.212510	-1.690279	-0.849372	-1.574329	0.995002	ARDL(5, 5, 5)
37	-14.799839	3.422204	4.213646	3.531333	0.536224	ARDL(4, 5, 5)
25	-23.149825	4.016647	4.659693	4.105315	0.530867	ARDL(5, 1, 5)
19	-22.635272	4.070586	4.763097	4.166074	0.446170	ARDL(5, 2, 5)
13	-22.609202	4.178800	4.920777	4.281109	0.263696	ARDL(5, 3, 5)

Source: Prepared by the researcher using EViews program

After examining 216 potential model specifications, the most suitable ARDL model for analyzing inflation in relation to both the reserve requirement rate and the discount rate has been identified as ****ARDL (5,5,5)****. This model incorporates a lag of five years for each of the three variables. The optimal specification of this model is as follows:

$$INF_t = \sum_{i=1}^5 \psi_i INF_{t-i} + \sum_{j=0}^5 \alpha_j LR_{t-j} + \sum_{m=0}^5 \beta_m RI_{t-m} + \varepsilon_t$$

$$INF_t = (\psi_1 INF_{t-1} + \psi_2 INF_{t-2} + \psi_3 INF_{t-3} + \psi_4 INF_{t-4} + \psi_5 INF_{t-5}) + (\alpha_0 LR_t + \alpha_1 LR_{t-1} + \alpha_2 LR_{t-2} + \alpha_3 LR_{t-3} + \alpha_4 LR_{t-4} + \alpha_5 LR_{t-5}) + (\beta_0 RI_t + \beta_1 RI_{t-1} + \beta_2 RI_{t-2} + \beta_3 RI_{t-3} + \beta_4 RI_{t-4} + \beta_5 RI_{t-5}) + \varepsilon_t$$

This is the best formulation of the ARDL model that best explains the relationship studied; The inflation rate in Algeria in a given year is linked to the effect of the reserve and rediscount rates of the previous five years

2-3-2- Estimation of the optimal formula for ARDL:

Using the estimation results from the previous equation in Appendix No. (2), the optimal ARDL model is presented as follows:

$$INF_t = (-0.22645688 INF_{t-1} - 0.41561703 INF_{t-2} + 0.71005405 INF_{t-3} + 0.73728038 INF_{t-4} + 0.82778891 INF_{t-5}) + (0.61893745 LR_t - 1.6117975 LR_{t-1} + 0.0405351 LR_{t-2} - 1.434849 LR_{t-3} + 1.1640002 LR_{t-4} - 1.098825 LR_{t-5}) + (-2.5886771 RI_{t-1} + 12.533292 RI_{t-2} - 2.5410681 RI_{t-3} + 5.5692638 RI_{t-4} - 7.9413390 RI_{t-5})$$

This represents the optimal specification for the Autoregressive Distributed Lag (ARDL) model used to explain the relationship under study. It demonstrates that the inflation rate in Algeria (INF) for the current year (t) is influenced by the reserve requirement (LR) and the discount rate (RI) over the past five years, as well as by previous levels of inflation. The following interpretations can be made based on this model:

The inflation rate in the current year (t) is related to the reserve requirement rates (LR) of the past five years, with statistical significance (at 5% and 10%, see Appendix 2) for the following relationships:

- A 1% increase in the current legal reserve ratio results in a 0.618937% increase in the inflation rate.
- A 1% rise in the current legal reserve ratio leads to a decrease in the inflation rate by -1.611798% after one year.
- An increase of 1% in the current legal reserve ratio results in a reduction in the inflation rate by -1.434849% after three years.
- A 1% increase in the current legal reserve ratio results in a rise in the inflation rate by 1.164000% after four years.
- A 1% increase in the current legal reserve ratio leads to a decrease in the inflation rate by -1.098826% after five years.

The inflation rate for the current year (t) is influenced by the discount rate (RI) from the past five years as follows:

- A 1% increase in the current year's discount rate results in a 12.53329% increase in the inflation rate after two years.
- An increase of 1% in the current year's discount rate leads to a 5.569264% rise in the inflation rate after four years.
- A 1% increase in the current year's discount rate results in a decrease in the inflation rate by -1.098826% after five years.

2-4- Testing for Cointegration Among Monetary Policy Tools and Inflation in Algeria:

To test for the existence of a long-term cointegrating relationship among the variables studied, we use the bounds test, after verifying the absence of estimation problems related to the classical assumptions of errors in the previous ARDL model:

- Homogeneity of Error Variance: According to Appendix (3), the ARCH test results show probability values for the Fisher and Lagrange multipliers at 0.0792 and 0.0713, respectively, both of which exceed the 5% significance level. Therefore, the hypothesis of homogeneity of error variance is supported.

- Normal Distribution of Residuals: Appendix (4) presents the results of the Jarque-Bera test, with a probability value of 0.2048, which is above the 0.05 threshold. This indicates that the residuals in the ARDL model follow a normal distribution.

- Autocorrelation of Errors: The Breusch-Godfrey test results provide probability values of 0.2389 and 0.1902 for the Fisher and Lagrange multipliers, respectively. These values suggest that the hypothesis of no autocorrelation in the residuals of the ARDL model can be accepted.

2-4-1 F-Bounds Test:

Acceptance of the three hypotheses confirms that the estimated ARDL model is appropriate for identifying a long-term equilibrium relationship through the bounds test. To test the null hypothesis (H_0): No cointegration), the F-statistic should be computed and compared against the critical bounds for $I(0)$ and $I(1)$ proposed in the literature.

Table No. (07): F-Bounds Test Results

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	591.6394	10%	2.17	3.19
k	2	5%	2.72	3.83
		2.5%	3.22	4.5
		1%	3.88	5.3

Source: Prepared by the researcher using EViews program

The computed F-statistic value of (F-statistic = 591.6394) significantly exceeds the upper critical values for (I(1)) at the 10%, 5%, and 1% significance levels, which are 3.19, 3.83, and 5.3, respectively. This allows us to reject the null hypothesis (H_0), which assumes no cointegration. Consequently, the alternative hypothesis is accepted, indicating that there is a long-term equilibrium relationship between the inflation rate in Algeria and the monetary policy tools (reserve requirement and discount rate). This relationship, as well as the speed of adjustment toward equilibrium in the short term, can be further estimated using an error correction model (ECM).

2-4-2 Estimating the long-term equilibrium relationship between monetary policy and inflation in Algeria:

$$INF_t = a_1 LR_t + a_2 RI_t + e_t$$

Table No. (08): The impact of monetary policy on inflation in the long term

Levels Equation Case 1: No Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LR	3.667959	0.474747	7.726135	0.0819
RI	-7.529333	1.151744	-6.537334	0.0966
EC = INF - (3.6680*LR -7.5293*RI)				

Source: Prepared by the researcher using EViews program

The long-run equilibrium relationship for inflation in terms of monetary policy instruments can be written as follows:

$$INF_t = 3.667959 LR_t - 7.529333 RI_t$$

It is clear that the long-term inflation rate is directly related to the reserve ratio (INF increases by 3.66 when LR increases by 1%); while the inflation rate is inversely related to the rediscount rate (INF decreases by 7.52 when RI increases by 1%)

There is statistical significance at the 10% level for these two long-term effects.

The equality in the previous equation shows the equilibrium position of the impact of monetary policy on inflation in the long run in Algeria, and any imbalance between its two sides expresses the imbalance error, which we symbolize with EC:

$$EC = INF - (3.667959 LR_t - 7.529333 RI_t)$$

5-2- Estimating the Error Correction Model and the Speed of Adjustment between Short and Long-Term in the Studied Relationship**:

Using Appendix No. Appendix No. (5), the error correction equation can be estimated as follows:

$$\begin{aligned} \Delta INF_t = & -1.8595 \Delta INF_{t-1} - 2.2751 \Delta INF_{t-2} - 1.5650 \Delta INF_{t-3} - 0.827789 \Delta INF_{t-4} + 0.6189 \Delta LR_t \\ & + 1.3291 \Delta LR_{t-1} + 1.3696 \Delta LR_{t-2} - 0.0651 \Delta LR_{t-3} + 1.098826 \Delta LR_{t-4} - 5.4423 \Delta RI_t \\ & - 7.6201 \Delta RI_{t-1} + 4.9131 \Delta RI_{t-2} + 2.3720 \Delta RI_{t-3} + 7.9413 \Delta RI_{t-4} - 0.633049 e_{t-1} \end{aligned}$$

One of the key advantages of the ARDL methodology in examining the cointegration between inflation and monetary policy is its capability to estimate not only the long-term equilibrium relationship but also the short-term error correction mechanism. This mechanism reveals how short-term deviations are corrected to achieve equilibrium. As demonstrated by the previous error correction model, this approach shows robust statistical power, particularly regarding the statistical significance of all its coefficients.

Interpretation of the Results

The error correction equation from the initial analysis provides insights into how short-term variations in both the reserve requirement ratio (LR) and the rediscount rate (RI) influence inflation (INF) in Algeria over the past four years. The coefficients in the equation capture both positive and negative effects.

Impact of Reserve Requirement Ratio (LR):

- **Current Year (t)** : Changes in LR have a positive effect on inflation in the current year.

- **Previous Years**:

- **Year $(t-1)$** : Positive impact.

- **Year $(t-2)$** : Positive impact.

- **Year $(t-4)$** : Positive impact.

- **Three Years Prior $(t-3)$** : Negative impact.

In summary, inflation in year (t) tends to increase with current and recent increases in the reserve requirement ratio, but it is negatively influenced by changes in LR from three years ago.

Impact of Rediscount Rate (RI):

- **Current Year (t)** : The effect of changes in RI is inversely related to inflation.

- **Previous Year $(t-1)$** : The inverse relationship continues.

- **Three Years Prior $(t-3)$** : Changes in RI from this period have a direct relationship with inflation.

In essence, inflation growth in year (t) decreases with higher RI in the current and previous year but increases with higher RI from three years ago.

The term $(-0.633049 e_{(t-1)})$ represents the error correction mechanism. It indicates how deviations from the long-term equilibrium state are adjusted. Specifically, if inflation in the previous period $(t-1)$ deviates from the equilibrium level, this term shows how 63.3% of this deviation is corrected in the following period (t) , guiding inflation back towards equilibrium.

If the equilibrium error $(e_{(t-1)} = 0)$, it indicates that the inflation rate in period $t-1$ is consistent with the long-term equilibrium state, which is given by:

$$INF_t = 3.667959 LR_t - 7.529333 RI_t$$

If the equilibrium error is positive $e_{t-1} > 0$, $[INF_{t-1} > (3.667959 LR_t - 7.529333 RI_t)]$, then when inflation exceeds its equilibrium value (as determined by the reserve ratio and rediscount rate) in period $t-1$, the coefficient -0.633049 works to reduce this deviation (by 63%) toward the equilibrium level in the following period t .

Conversely, if $e_{t-1} < 0$, meaning $[INF_{t-1} < (3.667959 LR_t - 7.529333 RI_t)]$, when inflation falls below its equilibrium value in period $t-1$, the positive value of the term $(\phi \times e_{(t-1)})$ contributes to increasing ΔINF_t , thus helping to correct 63% of this decrease in the following period t .

The error correction coefficient $|\phi|$ represents the speed at which the inflation rate in period t returns to its estimated long-term equilibrium level after a deviation in the previous period $t-1$. This indicates that the relationship between inflation and monetary policy tools always tends to revert to the long-term equilibrium level estimated earlier, with any deviation in the inflation rate in a given period (either above or below this level) being corrected by 63% in the following period.

For this error correction mechanism to be valid, the coefficient must be negative and significant. The first condition can be easily verified by the estimated coefficient value -0.633049 while the significance can be confirmed by the probability value $(\text{prob} = 0.0087)$ (see Appendix 05), which leads us to accept the hypothesis that the error correction coefficient is statistically significant.

Research Results:

- The results from the best ARDL model equation showed that an increase in the general price level in a given year is directly correlated with the growth of public expenditures in the previous three years. Specifically, the inflation rate increases by 5.3%, 8.9%, or 11.7% in year t when public expenditure growth increases by 1% in years $t-1$, $t-2$, or $t-3$, respectively.
- According to the cointegration test, there is a long-term equilibrium relationship that illustrates the positive impact of public expenditure expansion on the general level of consumer prices. A 1% increase in public expenditure growth results in a 0.467% increase in the general inflation rate. Any deviation from this relationship in a given year is corrected in the following year by 54%, which leads to the acceptance of the third hypothesis.

Research Recommendations:

- It is essential to utilize quantitative modeling methods to monitor macroeconomic indicators in the national economy and to establish a channel of communication between decision-makers in Algeria and academic researchers in econometrics. Ensuring that academic research in this field is effectively utilized, unlike the current situation.

Research Prospects:

The findings of this study open up new avenues for further research, including:

- Determinants of public spending in Algeria in the long and short term using ARDL models;
- Analysis of the impact of oil prices on the policies guiding public spending between the operating and equipment budgets.

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appendix list:

Appendix No. 1: Study data

Years	Rediscount rate RI	Required reserve ratio lr	Consumer price inflation rate inf
1990	10.5		20.2
1991	10.5		25.5
1992	11.5		30.0
1993	11.5		21.6
1994	15		31.7
1995	14		28.4
1996	13		20.3
1997	11		6.1
1998	9.5		6.2
1999	8.5		2.1
2000	6		-0.6
2001	6	3	3.5
2002	5.5	4.25	2.6
2003	4.5	6.25	3.7
2004	4	6.5	4.2
2005	4	6.5	2.8
2006	4	6.5	1.8

2007	4	8	4.3
2008	4	8	5.1
2009	4	8	6.5
2010	4	9	4.1
2011	4	9	5.8
2012	4	11	9.7
2013	4	12	4.1
2014	4	12	3.9
2015	4	12	4.4
2016	3.5	8	5.8
2017	3.5	4	5.9
2018	3.5	10	3.5
2019	3.5	10	2.4
2020	3	3	2.1
2021	3	2	6.6
2022	3	2	9.7
2023	3	3	9.36

Appendix 2: ARDL Model Estimation

Dependent Variable: INF Method: ARDL Date: 05/01/24 Time: 08:06 Sample (adjusted): 2006 2023 Included observations: 18 after adjustments Maximum dependent lags: 5 (Automatic selection) Model selection method: Akaike info criterion (AIC) Dynamic regressors (5 lags, automatic): LR RI Fixed regressors: Number of models evaluated: 180 Selected Model: ARDL(5, 5, 5)				
Variable	Coefficien t	Std. Error	t-Statistic	Prob.*
INF(-1)	-0.226457	0.033487	-6.762464	0.0935
INF(-2)	-0.415617	0.038105	-10.90702	0.0582
INF(-3)	0.710054	0.050384	14.09297	0.0451
INF(-4)	0.737280	0.054623	13.49772	0.0471
INF(-5)	0.827789	0.060926	13.58676	0.0468
LR	0.618937	0.077164	8.021054	0.0790
LR(-1)	-1.611798	0.051794	-31.11966	0.0205
LR(-2)	0.040535	0.063535	0.638000	0.6385
LR(-3)	-1.434849	0.080776	-17.76340	0.0358
LR(-4)	1.164000	0.063846	18.23143	0.0349
LR(-5)	-1.098826	0.053276	-20.62521	0.0308
RI	-5.442386	1.366317	-3.983252	0.1566
RI(-1)	2.588677	1.067880	2.424127	0.2491

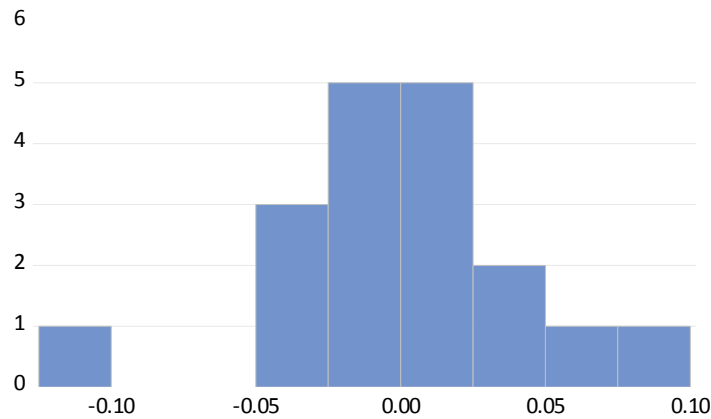
RI(-2)	12.53329	1.397130	8.970745	0.0707
RI(-3)	-2.541068	0.797822	-3.185005	0.1937
RI(-4)	5.569264	0.456117	12.21015	0.0520
RI(-5)	-7.941339	0.309299	-25.67530	0.0248
R-squared	0.999706	Mean dependent var	5.281111	
Adjusted R-squared	0.995002	S.D. dependent var	2.425565	
			-	
S.E. of regression	0.171472	Akaike info criterion	1.690279	
			-	
Sum squared resid	0.029403	Schwarz criterion	0.849372	
			-	
Log likelihood	32.21251	Hannan-Quinn criter.	1.574329	
Durbin-Watson stat	3.175899			
*Note: p-values and any subsequent tests do not account for model selection.				

Appendix No. 3

Heteroskedasticity Test: ARCH				
F-statistic	3.547868	Prob. F(1,15)	0.0792	
Obs*R-squared	3.251789	Prob. Chi-Square(1)	0.0713	
Test Equation: Dependent Variable: RESID^2 Method: Least Squares Date: 05/01/24 Time: 08:08 Sample (adjusted): 2007 2023 Included observations: 17 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
	t			
C	0.000978	0.000828	1.180926	0.2560
RESID^2(-1)	0.435805	0.231371	1.883578	0.0792
R-squared	0.191282	Mean dependent var	0.001704	

Adjusted R-squared	0.137367	S.D. dependent var	0.003255
S.E. of regression	0.003023	Akaike info criterion	8.654944
Sum squared resid	0.000137	Schwarz criterion	8.556919
Log likelihood	75.56702	Hannan-Quinn criter.	8.645200
F-statistic	3.547868	Durbin-Watson stat	1.637012
Prob(F-statistic)	0.079158		

Appendix No. 4



Normal distribution test:

Appendix No. 5

ARDL Error Correction Regression Dependent Variable: D(INF) Selected Model: ARDL(5, 5, 5) Case 1: No Constant and No Trend Date: 05/01/24 Time: 08:11 Sample: 1990 2023 Included observations: 18				
ECM Regression Case 1: No Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INF(-1))	-1.859506	0.024624	-75.51558	0.0084
D(INF(-2))	-2.275123	0.031737	-71.68691	0.0089

D(INF(-3))	-1.565069	0.029999	-52.17081	0.0122
D(INF(-4))	-0.827789	0.030604	-27.04855	0.0235
D(LR)	0.618937	0.026632	23.24024	0.0274
D(LR(-1))	1.329139	0.033389	39.80738	0.0160
D(LR(-2))	1.369674	0.029948	45.73458	0.0139
D(LR(-3))	-0.065175	0.017812	-3.659112	0.1698
D(LR(-4))	1.098826	0.020297	54.13625	0.0118
D(RI)	-5.442386	0.402061	-13.53623	0.0469
D(RI(-1))	-7.620149	0.364519	-20.90470	0.0304
D(RI(-2))	4.913143	0.274147	17.92156	0.0355
D(RI(-3))	2.372075	0.145018	16.35714	0.0389
D(RI(-4))	7.941339	0.167034	47.54318	0.0134
CointEq(-1)*	-0.633049	0.008675	-72.97092	0.0087
R-squared	0.999712	Mean dependent var	0.364444	
Adjusted R-squared	0.998366	S.D. dependent var	2.449188	
			-	
S.E. of regression	0.098999	Akaike info criterion	1.912501	
			-	
Sum squared resid	0.029403	Schwarz criterion	1.170525	
			-	
Log likelihood	32.21251	Hannan-Quinn criter.	1.810193	
Durbin-Watson stat	3.175899			
* p-value incompatible with t-Bounds distribution.				