Effectiveness of Monetary Policy in Controlling Inflation from the Perspective of the Tunisian Economy

Amel Aloui[1], Emna Bouslimi[2]

[1]CEDIMES Member, Associate Professor, FSJEGJ, VPNC Laboratory, Tunisia,
[2]PHD Student in Economics, FSJEGJ, VPNC Laboratory Tunisia,

Abstract
This paper aims to empirically examine, for Tunisia, the effects of monetary policy in fighting inflation using ARDL modeling. The study is based on time series data from 2000 to 2021. The results show that the key interest rate has a positive and statistically significant effect on long-term inflation. The monetarist theory is valid in the short term, while the structural theory of inflation is valid for the case of Tunisia in the short and long term. As a result, monetary policy in Tunisia, applied with the aim of curbing inflation, is not effective. The study therefore recommends that economic policies should focus directly on the factors behind inflation, mainly imported inflation.

Keywords: inflation, monetary policy, money supply, key interest rate, ARDL method

1. Introduction

After a decade of almost silent inflation, prices around the world began to surge in 2021 as the world's population returned to high consumption after the economic paralysis caused by the COVID-19 pandemic in 2020. The outbreak of war between Russia and Ukraine also added fuel to galloping inflation. These successive crises have dealt the world a heavy blow, not only economically, but also socially. This situation has affected most of the world's countries, particularly those with weak social protection systems, few job opportunities, high debt levels and significant financing needs, as in the case of Tunisia. This country has already been suffering from the inflation dilemma for over a decade, particularly since the 2011 revolution, and the situation has worsened due to the current global crisis, with the inflation rate reaching levels not seen for several decades, especially in 2022. As a result, the fight against this harmful phenomenon has become one of the Tunisian Central Bank's major concerns. However, despite its various interventions using the different tools at its disposal, inflation is on the rise. Thus, the thesis that inflation in Tunisia is not monetary has taken hold, raising further doubts about the effectiveness of monetary policy in combating inflation. This is indeed what motivated us to undertake this study in order to identify the extent and channels of impact of monetary policy on the inflation rate in Tunisia.
Within this framework and according to our research in the field, the particularity of our work can be identified in two parts:

- ✓ Firstly, to conduct an empirical investigation to go beyond theoretical and conceptual explanations.
- ✓ Secondly, to determine the effects of monetary policies in terms of fighting inflation, recorded mainly on the eve of the Tunisian revolution in 2011.

2. Literature Review

2.1 Conceptual Review

- **Monetary Policy**

Monetary policy can be defined as the set of measures, tools and actions taken by the monetary authority to control the volume and cost of money in a society or economy in order to achieve a predetermined macroeconomic objective, such as price stability, interest rate stability, exchange rate stability and the promotion of economic growth. It therefore consists in providing the liquidity needed for the economy to function properly and grow, while ensuring the internal and external stability of the currency. Many other definitions of this concept have been put forward by economists and international organizations:

According to S.Ikiemi (2010)[1] , “monetary policy refers to the authorities' action on the major economic balances through a policy of controlling the volume of money in circulation. It therefore encompasses all measures designed to influence the levels of economic activity and prices through the cost of money and credit".

According to M.Montoussé and D.Chamblay (2005)[2] ,"monetary policy refers to the action taken on economic variables by means of the quantity of money in circulation and interest rates”. For Bailly, Figliuzzi and Lelièvre (2000)[3], monetary policy is “the set of actions developed by a Central Bank and a government to influence the level of economic activity and maintain price stability, through the regulation of the quantity and of the cost of money.

From these various definitions of the concept of monetary policy, we can conclude that it is a powerful instrument of economic management, where the government takes various measures to promote economic development. It influences money supply, credit policy and interest rates. It therefore plays a decisive role in the economy.

- **Inflation**

Inflation is one of the most dreaded economic terms that monetary authorities try to curb at every turn. Low and stable inflation is necessary to maintain macroeconomic and financial stability that promotes investment and economic growth (Poole and Wheelock, 2008). It has been defined in several ways:

According to INSEE, inflation is the loss of purchasing power of money, resulting in a general and lasting increase in prices. It must be distinguished from increases in the cost of living. The loss in value of money is a phenomenon that affects the national economy as a whole (households, businesses, etc.). Moreover, the IMF (1974)[4] define the inflation as "the most complex and serious set of economic problems confronting the national government and the international community since the end of World War II consists of virulent and widespread inflation, a deceleration of economic growth, and a massive imbalance in international payments". We can conclude that inflation as a term has been defined by many economists in different ways, but one thing runs through it all, economists agree that inflation is an increase in overall prices over time.

[1] S.Ikiemi, (2010), « Le Franc CFA d’où vient-il ? Où vat-il ? ». Ed. L’Harmattan, 2010, p 115.
[2] Montoussé, M., & Chamblay, D. (2005). 100 fiches pour comprendre les sciences économiques. Editions Bréal.
[3] Bailly, J. L., Caire, G., Figliuzzi, A., & Lelièvre, V. (2000). Économie monétaire et financière. Bréal. p 217.
[4] IMF, (1974), ‘World Economic Outlook: Building Institutions’, International Monetary Fund, Washington, D.C.

2.2 Theoretical Review

Monetary policy has been the subject of much analysis in economic theory. These theories have created a broader and clearer understanding of the role of monetary policy in the economy, particularly with regard to price stability. Since the 1970 crisis, monetary policy has been dominated by three successive currents. These are monetarism, the new classical school and the new Keynesian economics. The current economic crisis of 2022 has led to a renaissance in monetarist thinking. In fact, many countries, including the United States and several other European countries, are now adopting restrictive monetary policies inspired by monetary theory, with successive increases in key interest rates and other restrictive measures.

From a monetarist perspective, monetary policy aims to maintain price stability by controlling the growth of the money supply. The fundamental idea is that prudent, predictable monetary policies help prevent excessive inflation and promote long-term economic stability. This is often at odds with the Keynesian idea that aggregate demand and discretionary fiscal policies are more important in influencing economic activity. As for the new classical school, it generally supports an approach known as "monetary neutrality", which means that changes in the money supply have no long-term effect on real output or employment, but only on prices. In other words, monetary policy can only influence the general price level in the economy, not real output or unemployment. Monetary policy should therefore aim to maintain stable growth in the money supply in order to avoid long-term inflationary pressures. According to New Keynesian economics, which represents an evolution of classical Keynesian theory by integrating elements of microeconomics into macroeconomic analysis, monetary policy plays a central role in stabilizing the economy by influencing nominal interest rates to achieve long-term inflation targets. The preferred approach is often inflation targeting, to guide economic agents' expectations and maintain macroeconomic stability.

2.3 Empirical review

In an empirical work in annual series data from 1973 to 2013, Chaudhry, Ismail, Farooq and Murtaza (2015)[5] studied the impact of money supply growth on the inflation rate in Pakistan in the short and long term. The ARDL technique is used, depending on the time series properties of the data, which confer a mixed order of integration. According to this study, the interest rate and money supply are important policy variables for controlling inflation in the long term.

Guizani (2015)[6] carried out empirical work on the effectiveness of monetary policy in Tunisia especially after the January 2011 revolution, using a monthly database of several macroeconomic variables over the period 2000 to 2013 and a vector error correction (VEC) model. The impulse response functions generated by VEC showed that the monetary policy stance, as measured by the short-term interest rate, became increasingly effective on real output and prices in the post-revolution period (2011 - 2013) compared to the previous period (2000 - 2010). The estimation results show a clear improvement in the interest rate channel during the transition period, and throughout this period, monetary policy has a stronger and faster impact on both real GDP and the general price level than in the pre-revolutionary period. In addition, an unexpected rise in the short-term interest rate will further control inflation.

[5] Chaudhry, I. S Ismail, R Farooq, F., and Murtaza G, (2015), «Monetary policy and its inflationary pressure in Pakistan», Pakistan Economic and Social Review, 53(2), pp 251-268.

[6] Guizani, B. (2015), « Effectiveness of Monetary Policy in Economies in Democratic Transition: Evidence from Tunisia », MPRA Paper No. 63205.

Jedidia, Dammak and Kamel (2019) [7] studied the role of openness in explaining inflation in Tunisia, using a quarterly measure of the consumer price index (CPI), trade openness (TRADE), money supply (M2), real effective exchange rate (REER) and real GDP per capita (GDPD) from Q1 1975 to Q4 2015. Variables were extracted from Tunisian Central Bank statistics, the International Financial Statistics database and the World Bank Indicators database. In addition, this study used a non-linear regression model. The main conclusion of these researchers states that trade integration can be used to control inflation when monetary tools fail. In addition, according to the study, the Tunisian authorities are urged to control money creation, on the one hand, and to focus on sectors likely to increase productivity and generate less inflation, on the other.

Nguyen, Papyrakis and Van Bergeijk (2019)[8] performed a VAR analysis to examine the effects of monetary policy on the real economy in Vietnam using monthly data from 1998 to 2017. In other words, since the “Central Bank Act” came into force in January 1998. They found evidence to suggest that monetary policy (through the manipulation of interest rates) is an effective policy tool for stabilizing prices. However, they also found that an expansionary credit policy (favored by policymakers at that time) was likely to create inflationary pressures and, consequently, act against the price-stabilizing effect of other monetary instruments.

Furthermore, an econometric study by Kumar and Dash (2020)[9] on the effects of a few monetary policy variables on aggregate, sectoral and disaggregated inflation in India from 1997 to 2017 using a large dataset of 439 variables, demonstrated that restrictive monetary policy became more effective in containing aggregate and sectoral inflation in more recent periods than in previous sample periods. However, this efficiency deteriorated slightly from 2010 to 2014. This could be attributed to adverse supply shocks such as the 2009 drought, a rise in global crude oil prices and household inflation expectations. They also showed that the effectiveness of this policy in controlling headline inflation has improved over time. According to these two researchers, this improvement can be attributed to better transmission through the credit and asset price channels, with the exception of 2010-2014. Furthermore, by studying disaggregated inflation, they noted that a restrictive monetary policy is more effective in reducing inflation in the manufacturing sector than in the agricultural sector. Regarding their suggestions, they suggested that it would be beneficial for the Indian Monetary Authority to develop a monetary rule where it can react to sectoral inflation with a different intensity depending on the nominal rigidity present in that sector.

Hussain and Hussain (2020)[10] carried out an empirical analysis to investigate empirically the influence of different macroeconomic variables on inflation in Pakistan using the OLS technique and Granger's non-causality test over a period from 1973-Q3 to 2017-Q2. The results confirmed that real GDP, money supply, imports and public spending had a favorable and substantial impact on inflation, while interest rates were

[7] Jedidia, K. B., Dammak, T. B., & Kamel, H., (2019), «Trade-threshold Effect on Inflation in Tunisia: New Evidence Resulting from a Nonlinear Approach», International Economic Journal, 33(1), pp 149-169.

[8] Nguyen, T. M. L., Papyrakis, E., & Van Bergeijk, P. A, (2019), “Assessing the price and output effects of monetary policy in Vietnam: Evidence from a VAR analysis», Applied Economics, 51(44), pp 4800–4819.

[9] Kumar, A., & Dash, P,(2020), «Changing Transmission of Monetary Policy on Disaggregate Inflation in India», Economic Modelling, 92 (November), pp 109-125.

[10] Hussain, S. I., & Hussain, A, (2020), «An Empirical Analysis in Effect of Macroeconomic Factors on Inflation for Pakistan», SSRN Electronic Journal, 81(1), pp 1-10.

damaged. Furthermore, the data showed bidirectional causality between money supply and inflation, and a unidirectional causal correlation between public spending and imports to inflation. Thus, according to this research, inflation in Pakistan is not entirely determined by monetary expansion; imports and fiscal policy are also important contributors to inflation. The analysis reveals that the main authorities would not achieve price stability through changes in monetary policy, except until the government resolves the fiscal imbalance.

N. Musa and O.D.Amuta (2021)[11] examined the effects of monetary policy in combating inflation in Nigeria. The study used annual time-series data from 1986 to 2019 from the Central Bank of Nigeria's statistical bulletin. They used the inflation rate as the dependent variable, while money supply, the policy rate, the exchange rate and government spending were used as explanatory variables. This study used the Autoregressive Distributed Lag (ARDL) model for its analysis. The results indicated that the interest rate and the exchange rate exerted a positive and significant effect on inflation in Nigeria in both the short and long term. However, the monetary policy rate had no significant influence on the inflation rate in the long term, but was significant in the short term. It was therefore concluded that while the interest rate and the exchange rate are powerful inflation control tools, the monetary policy rate is not very effective in controlling inflationary pressure in Nigeria. The study recommended that the Central Bank, in collaboration with the commercial banks, should control inflation by maintaining the interest rate at a reasonable level.

Using annual data from 1980 to 2019, Ezeanyeji, Imoagwu and Ejefobihi (2021)[12] performed an error correction model (ECM) estimation to investigate the role of monetary policy in controlling inflation in Nigeria. Variables include exchange rate, inflation rate, money supply (% of GDP), Treasury bill rate and monetary policy rate. The research results showed that monetary policy has no significant impact on inflation control in Nigeria, either in the short or long term. Money supply has a negative and insignificant impact on inflation control in Nigeria in both the short and long term. The study recommends that the state should provide an environment conducive to investment by removing the structural rigidity that exists in the economy.

As a conclusion to our review of conceptual, theoretical and empirical review, we have identified research gaps which are focused essentially on three areas, namely:

- ✓ The effect of monetary policy on prices remains inconclusive, both theoretically and empirically.
- ✓ Empirical evidence in Tunisia is uncertain as to the causes of price fluctuations and the effectiveness of monetary policy in controlling inflation.
- ✓ While some variables have a relatively greater influence on price behavior, the theoretical premise underlying price behavior in the Tunisian economy remains partially obscure, as the precise causal relationships still require further analysis.

In this context, this study attempts to improve on previous studies insofar as, in addition to the inclusion of non-monetary sources of inflation, the data samples used include data from 2000 to 2021. Thus, unlike most studies that have focused on the period leading up to the 2011 revolution, the period we have chosen

[11] Musa, N., & Amuta, O. D. (2021). EFFECTS OF MONETARY POLICY ON INFLATION IN NIGERIA. INTERDISCIPLINARY JOURNAL OF AFRICAN & ASIAN STUDIES (IJAAS), *7*(2), pp 105-115.

[12] Ezeanyeji, C. I., Obi, C. O., Imoagwu, C. P., & Ejefobihi, U. F. (2021). Monetary policy and inflation control: the case of Nigeria. European Journal of Management and Marketing Studies, 6(2).

to study covers the period of the global financial crisis, the period of democratic transition and the 2019 Covid crisis, as well as the crisis arising from the Ukrainian-Russian war.

3. Methodology

This study used the Autoregressive Distributed Lag (ARDL) model developed by Pesaran, Shin and Smith (2001)[13] to assess the effectiveness of monetary policy in combating inflation in Tunisia. The study used annual time series data on variables such as inflation rate, policy interest rate, money supply, exchange rate and oil price, covering the period from 2000 to 2021. The data used in our study was obtained from publications by the Tunisian Central Bank (BCT), the World Bank (WDI) and the "macrotrends" platform.

3.1 Model specification and estimation procedure

To verify whether monetary policy has an effect on inflation control in Tunisia and thus conclude that it is the tool to adopt to curb inflation, we will estimate a model inspired by the work of N.Musa and O.D.Amuta (2021), making modifications to the variables used. The functional form of the model is therefore specified as follows:

$$\mathbf{LnINF = f\,(lnMM, lnPP, lnTC, lnTXD)} \qquad (1)$$

Where: INF is the inflation rate, MM is the money supply, PP is the oil price, TC is the exchange rate and TXD is the key interest rate. If we want to capture the short-term and long-term effects of the above explanatory variables on inflation, the ARDL representation of function (1) will be:

$$\Delta lnINF_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i}\, \Delta lnINF_{t-i} + \sum_{i=0}^{q} \alpha_{2i} \Delta\, lnMM_{t-i} + \sum_{i=0}^{q} \alpha_{3i} \Delta\, lnPP_{t-i} + \sum_{i=0}^{q} \alpha_{4i}\, \Delta lnTC_{t-i}\ \sum_{i=0}^{q} \alpha_{5i} \Delta lnTXD_{t-i} + \beta_1 lnINF_{t-1} + \beta_2 lnMM_{t-1} + \beta_3 lnPP_{t-1} + \beta_4 lnTC_{t-1} + \beta_5 lnTXD_{t-1} + \varepsilon_t \qquad (2)$$

Δ: $first\ difference\ operator$;

$\alpha_0 1$: $constant$;

$\alpha_1 \ldots\ldots \alpha_5 : short - term\ effects$;

$\beta_1 \ldots . \beta_5 : long - term\ model\ dynamics$;

$\varepsilon \sim iid\ (0, \sigma)$: error term (white noise);

Since this is a dynamic model, we'll use the information criteria (Akaike-AIC and Schwarz-SIC) to determine the optimal shifts (p*, q*) of the ARDL model. According to J.K Kibala (2018)[14] , writing the ARDL model as above (equation 2) assumes the existence of a cointegration relationship between the variables that even conditions the estimation of the short- and long-run coefficients of these variables. There are many tests of cointegration, namely, Engel and Granger (1987)[15] , Johansen (1988, 1991)

---

[13] Pesaran, M. H., Shin, Y. and Smith, R. J. (2001), « Bounds testing approaches to the analysis of level relationships. », Journal of Applied Econometrics, 16, pp 289–326.

[14] Jonas Kibala Kuma, (2018), « Modélisation ARDL, Test de cointégration aux bornes et Approche de Toda-Yamamoto : éléments de théorie et pratiques sur logiciels », Licence, Congo-Kinshasa, p 24.

[15] Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. Econometrica: journal of the Econometric Society, 251-276.

Johansen and Juselius (1990)[16] , Pesaran et al. (1996), Pesaran and Shin (1995)[17] and Pesaran et al. (2001)[18]. Engle and Granger's cointegration test (1991) only applies to integrated variables of the same order (order of integration equal to 1), and is therefore less effective in multivariate cases. Although the Johansen test, which is based on vector autoregressive error correction modeling (VECM), alleviates this concern, it also requires all variables to be combined in the same order. This does not always happen in practice. When we have several integrated variables of different orders (integrate of order 0 and order 1), we can use the cointegration test of Pesaran et al. (2001), known as the "bounds cointegration test".
Following the procedure of Pesaran et al. (2001), the error correction model can confirm the existence or not of cointegration between variables. This model will be presented as follows for our study:

$$\Delta lnINF_t = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i}\, \Delta lnINF_{t-i} + \sum_{i=0}^{q} \alpha_{2i} \Delta\, lnMM_{t-i} + \sum_{i=0}^{q} \alpha_{3i} \Delta\, lnPP_{t-i} + \sum_{i=0}^{q} \alpha_{4i}\, \Delta lnTC_{t-i} + \sum_{i=0}^{q} \alpha_{5i} \Delta lnTXD_{t-i} + \theta u_{t-1} + \varepsilon_t \dots\dots (3)$$

Before estimating relationships 2 and 3, we will first check the level of integration of the variables using the two stationarity tests: Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP). Next, we examine whether there is a cointegration association between the variables using the cointegration test of Pesaran et al. (2001), commonly known as the bounds cointegration test. Finally, we test for causality between the variables under study by means of a causality test in the sense of Toda and Yamamoto.

4. Empirical results and interpretations

4.1 Analysis of series stationarity

To study the stationarity of the variables used in this work and define the nature of the series, two stationarity tests were applied: the Augmented Dickey-Fuller (ADF) test and the Phillips Perron (PP) test.

- **Augmented Dickey-Fuller test (ADF)**

According to Benyacoub and Es-Salmani (2021), Dickey-Fuller (1981) tests can be used to show whether a series is stationary or not, by determining a deterministic or stochastic trend. At the end of a sequential procedure, we test the null hypothesis of unit root (non-stationary) by comparing the t-statistic of φ with the values tabulated by Dickey and Fuller.

Table 2: The Augmented Dickey-Fuller (ADF) test:

Variables	ADF		Order of integration
	Levels	First differences	
lnINF	1.71(0.9992)	-6.33(0.0000) ***	**I(1)**
lnMM	-4.04(0.0058)***	_	**I(0)**
lnTC	0.89 (0.9931)	-2.90 (0.0633)*	**I(1)**

16 Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—with appucations to the demand for money. Oxford Bulletin of Economics and statistics, 52(2), 169-210.
17 Pesaran, M. H., & Shin, Y. (1995). An autoregressive distributed lag modelling approach to cointegration analysis (Vol. 9514). Cambridge, UK: Department of Applied Economics, University of Cambridge.
18 Pesaran, M. H., Shin, Y. and Smith, R. J. (2001), « Bounds testing approaches to the analysis of level relationships. », Journal of Applied Econometrics, 16, pp 289–326.

lnTXD	-1.60 (0.4650)	-4.37 (0.0030) ***	**I(1)**
lnPP	-2.15 (0.2301)	-5.38 (0.0095) ***	**I(1)**

Note: *, **, *** represent 10%, 5%, and 1% significance level, respectively.

Source: All results are computed by authors

The test results in Table 2 show that the lnINF, lnTC, lnTXD and lnPP oil series are integrated of order 1 (stationary after the first difference). In fact, the probabilities associated with the level ADF statistic are greater than 0.05, the unit root hypothesis cannot be rejected. These series are therefore non-stationary, and the best way to make them stationary is to pass them through first-difference filters. On the other hand, lnMM remains stationary at level (without differentiation), so it is integrated of order 0.

- **Phillips Perron (PP) test:**

The Phillips-Perron (1988)[19] test extends the Dickey-Fuller procedure by considering the possibility of trend breaks in series. This test follows the same procedure as the ADF test. The critical values are the same as those tabulated by Dickey-Fuller.

Table 3: Phillips Perron test (PP)

Variables	PP		Order of integration
	Levels	First differences	
lnINF	4.54(1.0000)	-6.35(0.0000)***	**I(1)**
lnMM	-4.03(0.0060)***	_	**I(0)**
lnTC	0.66 (0.9879)	-2.91 (0.0620) *	**I(1)**
lnTXD	-1.66 (0.4360)	-4.37 (0.0030) ***	**I(1)**
lnPP	-2.01 (0.2800)	--6.07 (0.0001) ***	**I(1)**

Note: *, **, *** represent 10%, 5%, and 1% significance level, respectively.

Source: All results are computed by authors

The test results in Table 3 show that the lnINF, lnTC, lnTXD and lnPP series are integrated of order 1 (stationary after the first difference). In fact, the probabilities associated with the PP level statistic are greater than 0.05, the unit root hypothesis cannot be rejected. These series are therefore non-stationary, and the best way to make them stationary is to pass them through first-difference filters. On the other hand, the money supply remains stationary at level (without differentiation). This lnMM series is then integrated of order 0.

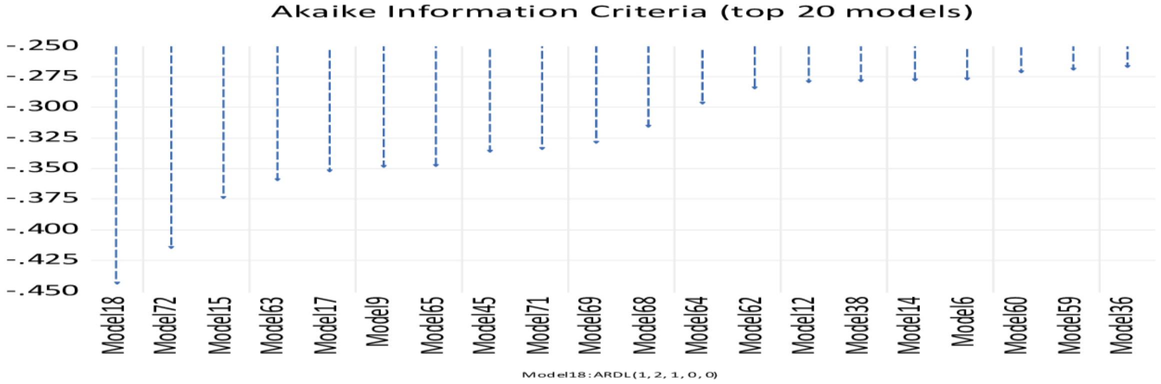
The two stationarity tests show that the lnINF, lnTC, lnTXD and lnPP series are integrated of order 1 (stationary after the first difference), while lnMM remains stationary at level. The series are therefore not integrated at the same order, which makes it inefficient to perform the Engle and Granger (multivariate case) and Johansen cointegration tests. To overcome this problem of integration at different orders, we can use the cointegration test of Pesaran et al. (2001).

[19] Phillips, P. C. B., Perron, P, (1988), « Testing for a unit root in time series regression», Biometrika, 75, pp 335–346.

4.2 Cointegration test by Pesaran et al (2001)

As long as the variables are integrated at different orders I (0), I (1) and none of them is I (2), the cointegration criterion should be applied to Pesaran's bounds. But before proceeding with the cointegration test, we must first select the most optimal model, and then give an estimate of the selected model. To select the optimal ARDL model that gives statistically significant results with the least parameters, we'll use the Akaike Information Criterion (AIC). The graph below shows the most optimal model chosen:

Figure 1: AIC graphic values



Source: author

Based on the above graph and according to the AIC criterion, the ARDL model (1, 2, 1, 0, 0) is the most optimal of the 19 others, as it gives the lowest AIC value. So it's the model that gives statistically significant results. Given that the most optimal model is ARDL (1, 2, 1, 0, 0); its estimate is given in the table below:

Table 4: Coefficient estimation results

Dependent variable: inflation rate

Selected Model: ARDL(1, 2, 1, 0, 0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNINF(-1)	-0.436700	0.259070	-1.685641	0.1200
LNMM	-0.018529	0.115455	-0.160485	0.8754
LNMM(-1)	-0.078067	0.116830	-0.668213	0.5178
LNMM(-2)	-0.166179	0.104232	-1.594314	0.1392
LNPP	0.289622	0.125865	2.301047	0.0420
LNPP(-1)	0.272532	0.115893	2.351591	0.0384
LNTC	0.833732	0.241309	3.455040	0.0054
LNTXD	0.771154	0.367351	2.099227	0.0597
C	-5.654145	1.371994	-4.121114	0.0017

R-squared	0.853864	Mean dependent var	-3.209000
Adjusted R-squared	0.747583	S.D. dependent var	0.331804
S.E. of regression	0.166702	Akaike info criterion	-0.443056
Sum squared resid	0.305685	Schwarz criterion	0.005023
Log likelihood	13.43056	Hannan-Quinn criter.	-0.355586
F-statistic	8.034032	Durbin-Watson stat	2.300242
Prob(F-statistic)	0.001186		

Source: All results are computed by authors

4.3 Diagnostic tests for the ARDL model

In this section, diagnostic tests aimed at assessing the robustness of our ARDL model were carried out. These are:

- **Autocorrelation test**

The autocorrelation test was performed using the Lagrange multiplier for residual autocorrelation (Breusch-Godfrey LM-test). The results are shown in the following table:

Table 5: autocorrelation test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 1 lag

F-statistic	0.752625	Prob. F(1,10)	0.4060
Obs*R-squared	1.399891	Prob. Chi-Square(1)	0.2367

Source: All results are computed by authors

According to this table, the test probability is greater than 5% (critical threshold) then the residuals are not autocorrelated, which is paramount for the continuation of our estimates.

- **Heteroskedasticity test**

This is one of the essential assumptions of linear models. Residuals are said to be heteroscedastic if they do not have the same variance. To check whether residuals are heteroscedastic or homoskedastic, the following tests can be used: Breusch-Pagan-Godfrey test and ARCH test (White-test). The results are presented in Table 6.

Table 6: Breusch-Pagan-Godfrey and ARCH tests (White-test).

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	0.427347	Prob. F(8,11)	0.8813
Obs*R-squared	4.742118	Prob. Chi-Square(8)	0.7847
Scaled explained SS	2.585855	Prob. Chi-Square(8)	0.9576

Heteroskedasticity Test: ARCH

F-statistic	0.228744	Prob. F(1,17)	0.6385
Obs*R-squared	0.252260	Prob. Chi-Square(1)	0.6155

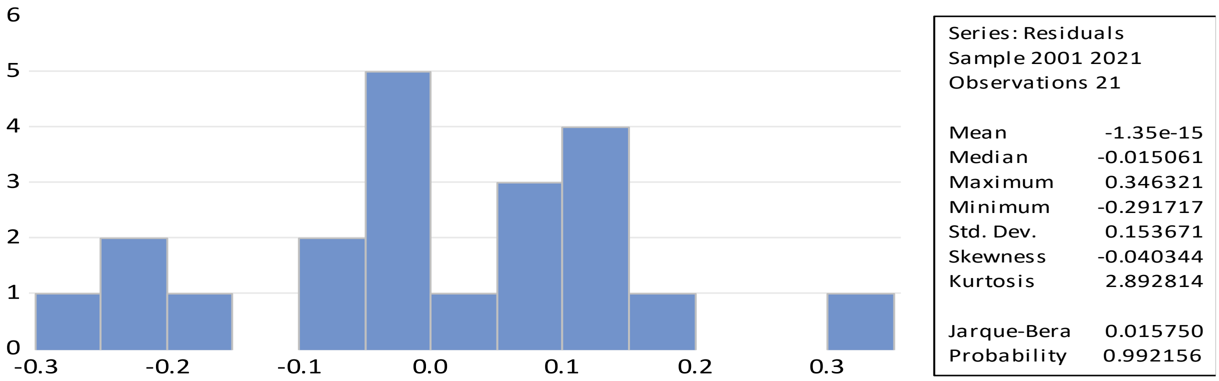
Source: All results are computed by authors

From the table above, we can see that the residuals are not heteroscedastic, since the F-statistic probabilities are greater than 5%. We accept H_0, which means that the errors are homoscedastic and the variance of the residuals in our model is constant.

- **Normality test**

The Jarque-Bera normality test was performed to determine the distribution of residuals in the model. The results of the normality test are shown in Figure 2.

Figure 2: Results of the Jarque-Bera normality test



Source: authors

From the results of the normality test, we can see that the Skewness coefficient (-0.040344) is different from zero (the theoretical value of the Skewness coefficient for a normal distribution). This coefficient shows the presence of asymmetry in the residual series curve. The coefficient of this asymmetry is negative, allowing us to say that the distribution is skewed to the left. What's more, the Kurtosis coefficient (2.892814) is lower than the Kurtosis value of the normal distribution (which is equal to 3). This reflects the fact that the residual series curve is less flattened than the normal distribution curve. This coefficient value reflects the high probability of extreme points occurring. Finally, the result of this test shows a probability value of 0.992156, which is greater than 0.05. Thus, the residuals are Gaussian white noise (the residual is normally distributed).

- **Ramsey specification test**

It's important to know whether the model is well specified or not, since the ARDL model includes lagged variables. The Ramsey test will be used for this purpose.

Table 7: Ramsey test

	Value	***df***	***Probability***
t-statistic	0.902654	10	0.3879
F-statistic	0.814784	(1, 10)	0.3879
Likelihood ratio	1.566581	1	0.2107

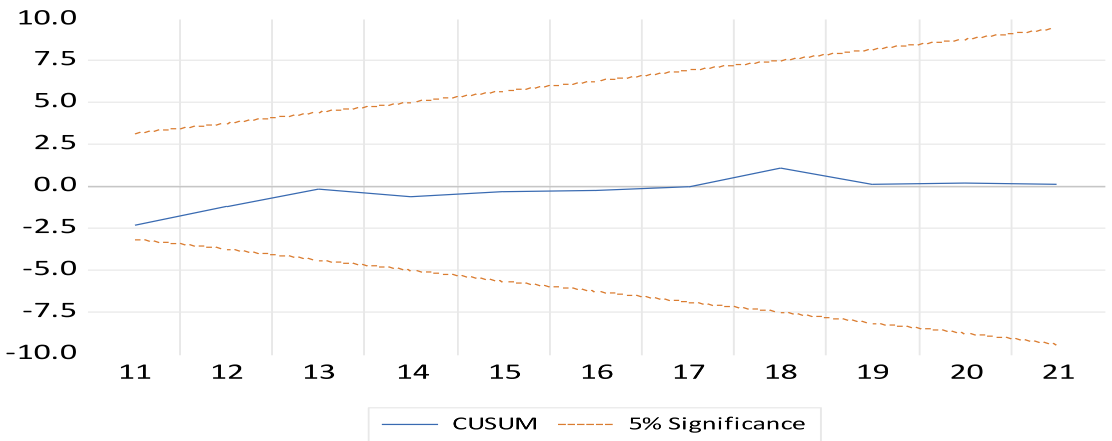
Source: All results are computed by authors

From the results of this test, we can see that the model is well specified, since the values of the three probabilities are greater than 0.05 (we accept H_0).

- **Stability Test**

To determine the stability of the model, the CUSUM test is the most relevant. The result of stability test is presented in the figure 3.

Figure 3: CUSUM graph



Source: authors

According to the analysis, the CUSUM graph is within the two critical limits at the 5 percent level. We therefore conclude that the model passes the stability test. According to this result, we can say that the estimated model is stable and therefore the coefficients are stable over time.

In short, the results of the various diagnostic tests (the null hypothesis is accepted for all these tests) have led to the statistical validation of our ARDL (1, 2, 1, 0, 0) model, since it has all the properties we were looking for.

4.4 Bounds Test for Co-integration

This is the most important step, aimed at testing whether or not there is a long-term equilibrium relationship between the variables. For this, we use the Pesaran bounds cointegration test. The value of the test statistic calculated is compared with the critical values forming the bounds. The results of the cointegration test are shown in Table 8.

Table 8: Results of the ARDL Bounds Test for Co-integration

Variables	**lnINF, lnMM, lnTC, lnTXD, lnPP**	
F-Statistic	5.512113	
Significance	**Lower Bound**	**Upper Bound**
10%	2.2	3.09
5%	2.56	3.49
2.5%	2.88	3.87
1%	3.29	4.37

Note: Upper bound and lower bound are obtained from Pesaran, Shin and Smith (2001)

Source: Computed by the Authors

The results of the cointegration test confirm the existence of a cointegration relationship between the series under study, since the value of F-statistic 5.904410 is > that of the upper bound. In other words, there is evidence of a long-term relationship between the variables in the model.

4.5 Correlation and causality between variables

In this section, we present the correlation and causality between variables in the model.

- **Correlations**

The link (or correlation) between the two variables is symbolized by the letter r and measured with a value ranging from "1" to "+1". (0) indicates no connection, while "1" implies the perfect or greatest connection. The letter r indicates the connection path. A negative r indicates that the variables are negatively linked.

Table 9: Correlations between variables

	LNINF	**LNMM**	**LNPP**	**LNTC**	**LNTXD**
LNINF	1	-0.1869446	0.51163461	0.76990011	0.17718562
LNMM	-0.1869446	1	-0.0049729	-0.1006753	0.17388159
LNPP	0.51163461	-0.0049729	1	0.15690235	-0.3803652
LNTC	0.76990011	-0.1006753	0.15690235	1	0.42808535
LNTXD	0.17718562	0.17388159	-0.3803652	0.42808535	1

Source: All results are computed by authors

The correlation test was performed to show the relationship between these variables. Table 9 shows that the association between inflation and both the exchange rate and the oil price are positive and very strong. In addition, a positive but weak relationship can be observed between the inflation rate and the policy rate. On the other hand, the correlation between the inflation rate and the money supply is weak, with a negative sign.

- **Causality between variables**

When non-stationary variables are not cointegrated or are integrated at different orders, the traditional Granger causality test becomes ineffective. In this case, we use the Toda-Yamamoto (1995) causality test, based on the Wald "W" statistic, which is chi-square distributed. The null hypothesis is that there is no causality between variables (probability > 5%).

Table 10: Toda-Yamamoto Causality Test results

*D*ependent variable	causal variables				
	lnINF	**lnMM**	**lnPP**	**lnTC**	**lnTXD**
LnINF	-	3.44 (0.18)	8.04 (0.02) **	21.70 (0.00) ***	1.2 (0.55)
LnMM	1.98 (0.37)	-	1.25 (0.54)	1.25 (0.53)	0.09 (0.78)
LnPP	4.64 (0.09)*	8.89 (0.01) **	-	2.48 (0.29)	10.12 (0.01) **
lnTC	0.40 (0.82)	0.30 (0.86)	0.06 (0.97)	-	3.04 (0.22)
lnTXD	2.14 (0.34)	1.46	5.35 (0.07)*	0.46 (0.79)	-

Note: *, **, *** represent 10%, 5%, and 1% significance level, respectively.
Source: All results are computed by authors

Table 10 suggests:

- ✓ A bidirectional relationship between the inflation rate and the oil price at a significance level of 5% and 10%.
- ✓ A bidirectional relationship between the key interest rate and the oil price at a significance level of 5% and 10%.
- ✓ A short-term unidirectional relationship from the exchange rate to the inflation rate at a significance level of 1%.
- ✓ A short-term unidirectional relationship from money supply to oil price at a significance level of 5%.

The results imply that external factors such as the exchange rate and oil prices dominate internal factors in driving up the price level in the country, hence the importance of imported inflation.

4.6 Short and long-run model estimations

After establishing the cointegration relationship, we proceeded to estimate the ARDL model to show the dynamic effect in the short and long term.

- **Short-run coefficients (ST)**

According to the results of the short-term dynamic effect in Table 11, we can see that the time dimension is an important variable not to be ignored: at least one year must pass before the increase in the money supply stimulates inflation. In other words, the one-year lag in the value of the money supply has a positive and significant effect on the inflation rate, where a 1% increase in the money supply raises inflation by 0.16%. In this case, monetary economic theory, which postulates a direct and proportional relationship between money and inflation, is confirmed. Similarly, an increase in the world price of oil has a positive and significant effect on the short-term inflation rate. In this sense, a 1% rise in the price of oil increases inflation by 0.28%. This is because Tunisia is an energy-dependent country, and its currency is fragile against the dollar. Consequently, higher oil prices contribute directly to increased energy expenditure and input costs.

The error correction coefficient (ECM) has the correct sign (negative: -1.44) and is statistically significant at 1%, confirming the existence of an error correction mechanism. Thus, 144% adjustment speed after a shock produced in previous years is corrected after less than a year. In other words, a deviation from long-term equilibrium following a short-term shock is corrected after approximately 8 months.

Table 11: Estimation results for TC coefficients

Dependent variable: D(LNINF)				
Variable	Coefficient	Std.Error	t-Statistic	Prob
D(LNMM)	-0.018529	0.071239	-0.260092	0.7996
D(LNMM(-1))	0.166179	0.069609	2.387324	0.0360
D(LNPP)	0.289622	0.083541	3.466826	0.0053
CointEq(-1)*	-1.436700	0. 207142	-6.935829	0.0000

Source: All results are computed by authors

- **Long-term coefficients (LT)**

Having shown the short-term dynamic effect, we move on to the long-term dynamic effect.

Table 12: ARDL Long-run Estimation Results

Variable	**Coefficient**	**Std.Error**	**t-Statistic**	**Prob**
lnMM	-0.182902	0.138770	-1.318026	0.2143
lnPP	0.391282	0.076318	5.126965	0.0003
lnTC	0.580311	0.126198	4.598427	0.0008
lnTXD	0.536754	0.237273	2.262175	0.0449
C	-3.935509	0.621446	-6.332827	0.0001
R-squared	**Adjusted R-squared**	**F-statistic**	**Prob (F-statistic)**	**Durbin-Watson on stat**
0.853864	0.747583	8.034032	0.001186	2.300242

Source: All results are computed by authors

The long-run analysis in Table 12 shows that, since the coefficient of the key interest rate is 0.536754 with a probability value of 0.0449, it exerts a positive and statistically significant effect on inflation. Thus, a 1% increase in the key interest rate will raise the inflation rate by around 0.53%. So the key interest rate is a major contributor to inflation. The economic implication of this finding is that an increase in the key interest rate will push up the cost of credit, which in turn will affect household purchasing power. As a result, this deterioration in household living standards fuels wage demands and, in turn, the inflationary spiral. Moreover, this positive relationship can be explained by the inability to control the liquidity exchanged on the parallel market, which accounts for a large proportion of the total volume circulating on the national territory.

As in the short term, the effect of oil prices on the inflation rate remains positive in the long term, and is more than proportional, since a 1% increase in oil prices accelerates inflation by 0.39%. Of course, this result is not surprising given our country's dependence on imported oil and the sensitivity of the prices of goods and services to oil shocks. Thus, the price of oil on the international market is inextricably linked to inflation.

Furthermore, the long-term estimates postulated that the exchange rate is the most important determinant of inflation in Tunisia over the period 2000-2021 and, as indicated, statistically significant at 1%. Indeed, a 1% increase in the exchange rate would lead to an increase of around 0.58% in the inflation rate. So rising exchange rates are triggering inflation in Tunisia. Economically, this can be explained by the fact that the depreciation of the dinar against the US dollar has led to higher prices for imported products, particularly in agriculture and oil. What's more, the fall in the dinar is pushing up the price of locally-produced goods and services through the mechanism of indexing world prices to local products, which in turn will result in wage demands. As a result, inflation feeds on itself.

Based on these results, we can conclude that the structural theory of inflation advocated by Myrdal and many other economists is valid for Tunisia. In contrast to its short-term effect, the long-term "money supply" control variable has a negative but statistically insignificant effect with a probability above 5% (0.2143).

The coefficient of determination R^2 is 0.853864. This indicates high explanatory power, meaning that around 85% of the systematic variation in the dependent variable is caused by changes in the explanatory variables, while the remaining unexplained 15% is captured by the disturbance term (ε). This implies that, the regression model has a good fit. The F-statistic of the regression model is 0.853 with a corresponding probability value of 0.0011. This indicates that all variables are statistically significant at the 5% level. The Durbin-Watson statistic of 2,300 indicates the absence of autocorrelation, and is therefore robust for policy analysis.

5. Conclusion and recommendations

According to our research in the field, the particularity of our work can be identified in two components:

- ✓ Firstly, we conducted an empirical investigation in order to go beyond theoretical and conceptual explanations;
- ✓ Secondly, we determined the effects of monetary policies in terms of the fight against inflation, recorded mainly on the eve of the Tunisian revolution in 2011.

This study assessed the effect of monetary policy on inflation in Tunisia using annual time-series data for the period 2000-2021. The study used an autoregressive distributed lag (ARDL) approach for the analysis. According to the short-term results, a one-year lag in the value of the money supply has a positive and significant effect on the inflation rate. This is consistent with monetarist economic theory. Similarly, the world oil price has a positive and significant effect. Regarding long-term results, the key interest rate, the oil price and the exchange rate all have positive and significant effects on the inflation rate. This reflects the importance of external factors, as inflation in Tunisia is mainly imported. In short, the results we have obtained suggest that inflation in Tunisia is not monetary, but mainly imported, which explains why the monetary policy adopted is not very effective.

Based on the results, the study recommended the following:

- ➢ Economic policy must directly address the root causes of inflation, mainly imported inflation. In other words, Tunisia should aim to achieve self-sufficiency in the products most damaging to its balance of trade, giving priority to energy and cereals. In this context, it should be pointed out that Tunisia is capable of limiting its energy dependence thanks to its great potential in renewable energies, particularly solar and wind power;
- ➢ In order to reduce its dependence on agricultural and food imports, Tunisia can benefit from the experience of certain Asian countries in terms of green revolution;

- Tunisia can also follow the experience of Africa's agricultural leader, Ethiopia, which has become one of the world's most successful economies by making agriculture the mainstay of the economy, and by making agricultural modernization an absolute priority with the aim of ensuring the country's food security.

Briefly, the fight against inflation should be the responsibility of both the BCT and the government. On the one hand, the central bank must maintain a strong and efficient exchange rate system to guarantee exchange rate stability. On the other hand, the government should implement solutions that create wealth, support investment in renewable energies and ensure food security.

6. References

1. Bailly, J. L., Caire, G., Figliuzzi, A., & Lelièvre, V. (2000). Économie monétaire et financière. Bréal. P 217.
2. Benyacoub, B et Es-Salmani, M., (2021), « Modélisation ARDL, test de cointégration aux bornes pour la vérification de la soutenabilité de la dette publique au Maroc », Revue Internationale du Chercheur, 2(4), p 10.
3. Chaudhry, I. S Ismail, R Farooq, F., and Murtaza G, (2015), «Monetary policy and its inflationary pressure in Pakistan», Pakistan Economic and Social Review, 53(2), pp 251-268.
4. Dickey, D.A. and Fuller, W.A., (1981), «Likelihood Ratio Statistics for Autoregressive Time Series with Unit Root », Econometrica, 49, pp 1057-1072.
5. Engle, R., & Granger, C. (1991). Long-run economic relationships: Readings in cointegration. Oxford University Press.
6. Engle, R. F., & Granger, C. W. (1987). Co-integration and error correction: representation, estimation, and testing. Econometrica: journal of the Econometric Society, 251-276.
7. Ezeanyeji, C. I., Obi, C. O., Imoagwu, C. P., & Ejefobihi, U. F. (2021). Monetary policy and inflation control: the case of Nigeria. European Journal of Management and Marketing Studies, 6(2).
8. Guizani, B. (2015), « Effectiveness of Monetary Policy in Economies in Democratic Transition: Evidence from Tunisia », MPRA Paper No. 63205.
9. Hussain, S. I., & Hussain, A, (2020), «An Empirical Analysis in Effect of Macroeconomic Factors on Inflation for Pakistan», SSRN Electronic Journal, 81(1), pp 1-10.
10. IMF, (1974), 'World Economic Outlook: Building Institutions', International Monetary Fund, Washington, D.C.
11. Jedidia, K. B., Dammak, T. B., & Kamel, H., (2019), «Trade-threshold Effect on Inflation in Tunisia: New Evidence Resulting from a Nonlinear Approach», International Economic Journal, 33(1), pp 149-169.
12. Johansen, S. (1991). Estimation and hypothesis testing of cointegration vectors in Gaussian vector autoregressive models. Econometrica: journal of the Econometric Society, 1551-1580.
13. Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration—with applications to the demand for money. Oxford Bulletin of Economics and statistics, 52(2), 169-210.
14. Johansen, S. (1988). Statistical analysis of cointegration vectors. Journal of economic dynamics and control, 12(2-3), 231-254
15. Jonas Kibala Kuma, (2018), « Modélisation ARDL, Test de cointégration aux bornes et Approche de Toda-Yamamoto : éléments de théorie et pratiques sur logiciels », Licence, Congo-Kinshasa, p 24.

16. Kumar, A., & Dash, P, (2020), «Changing Transmission of Monetary Policy on Disaggregate Inflation in India», Economic Modelling, 92 (November), pp 109-125.
17. Montoussé, M., & Chamblay, D. (2005). *100 fiches pour comprendre les sciences économiques*. Editions Bréal.
18. Musa, N., & Amuta, O. D. (2021). EFFECTS OF MONETARY POLICY ON INFLATION IN NIGERIA. *INTERDISCIPLINARY JOURNAL OF AFRICAN & ASIAN STUDIES (IJAAS)*, *7*(2), pp 105-115.
19. Nguyen, T. M. L., Papyrakis, E., & Van Bergeijk, P. A, (2019), "Assessing the price and output effects of monetary policy in Vietnam: Evidence from a VAR analysis», Applied Economics, 51(44), pp 4800–4819.
20. Pesaran, M. H., Shin, Y. and Smith, R. J. (2001), « Bounds testing approaches to the analysis of level relationships. », Journal of Applied Econometrics, 16, pp 289–326.
21. Pesaran, M. H., & Shin, Y. (1995). An autoregressive distributed lag modelling approach to cointegration analysis (Vol. 9514). Cambridge, UK: Department of Applied Economics, University of Cambridge.
22. Poole, W. ET Wheelock, D, (2008), «Stable prices, stable economy: keeping inflation in check must be no. 1 goal of monetary policymakers», The Regional Economist, Reserve Bank of St. Louis, p7.
23. Phillips, P. C. B., Perron, P, (1988), « Testing for a unit root in time series regression», Biometrika, 75, pp 335–346.
24. S.Ikiemi, (2010), « Le Franc CFA d'où vient-il ? Où vat-il ? ». Ed. L'Harmattan, 2010, p 115.
25. Toda, H.Y., Yamamoto, T., 1995. Statistical inference in vector autoregressions with possibly integrated processes. Journal of Econometrics 66, 225–250