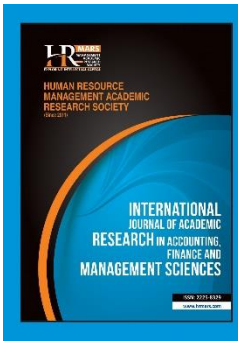

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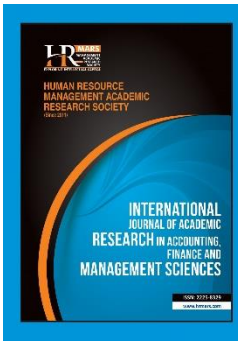
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Inflation and Real Measure of Central Bank Independence in Tunisia

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Abstract
The purpose of this paper is to detect the causes of inflation in Tunisia and to verify the existence of a causal relationship between central bank independence and inflation. Thus, we proved, using an ARDL model, that inflation in Tunisia is essentially explained by the variation of exchange rates, the turnover of the central bank governor, the credits granted to the private sector and the variation of interest rates which exerts a perverse effect. In this context, the analysis of inflation in Tunisia has allowed us to show that this phenomenon cannot be explained solely by monetary variables. Moreover, we have highlighted the existence of a positive impact of interest rates on inflation.
In addition, we have detected a new cause of inflation in Tunisia which is imports. This variable positively affects inflation in the long run. These results show that inflation in Tunisia is essentially a monetary and demand inflation in the short run. In the long run, inflation is also the result of structural factors that can be represented either by structural imbalances in the different markets, or by problems related to the quality of institutions or corruption.
Keywords: Inflation, Central Bank Independence, Credit, Exchange Rate, Money Market Rate.

Introduction

Since the Revolution, Tunisia has suffered from a succession of inflationary waves which are increasingly significant and which affect the purchasing power of households, particularly those with low incomes. Indeed, the various governments have tried to limit this phenomenon by trying to regulate the behaviour of suppliers. For its part, the Central Bank has tried to curb inflation by increasing the key rate, but in vain; the latter continues to rise, which leads us to look for other factors that may affect the variation of prices in Tunisia.
Inflation in Tunisia is a complex phenomenon that is difficult to understand since it results from several causes that can be monetary and non-monetary. The determinants of inflation have been the subject of several works (Darrat, 1986; Deme and Fayissa, 1995; Khemiri and Ali, 2012)
However, with the persistence of this phenomenon in Tunisia, we try to detect the determinants of inflation in our country. Thus, we verify the existence of a relationship between inflation, the independence of the central bank and imports, which are two phenomena that are experiencing a strong evolution.

In a first step, we proceed to a theoretical analysis in which we identify the phenomenon of inflation as well as its causes and consequences on the economy. Within this framework, we argue that inflation is a complex phenomenon which, according to theoretical investigations, can be caused by several factors such as monetary variables, production costs, demand in the economy and structural factors related to persistent imbalances and the quality of institutions. Similarly, we proceed to a descriptive analysis of the evolution of inflation in Tunisia. we find that prices have gone through periods of stability and periods of fluctuations that were generally accompanied by exceptional circumstances.

1. Inflation and Central Bank Independence

Several studies have tried to identify the determinants of inflation. This was done using several techniques, looking at different time periods and different countries. When investigating the sources of inflation, researchers have used several indicators, but we find that some variables are repeated in most empirical studies, such as: money supply, interest rates, exchange rate, gross domestic product, budget deficit, and central bank independence. As for many other economies in the world, many researchers have tried to analyze the determinants of inflation in the Tunisian economy.

Darrat (1986) attempted to use quarterly data from 1960 to 1980 to analyze the determinants of inflation in three North African countries (Tunisia, Morocco and Libya) in order to verify the monetarist view of inflation. The results show that inflation in these three countries is positively affected by foreign interest rates. Foreign interest rates represent the average quarterly interest rate and the growth rate of the money supply in the Organisation for Economic Co-operation and Development and are affected by GDP. The results of Darrat (1986) show that the monetarist model can explain inflation in Tunisia, Morocco and Libya during the study period.

Deme and Fayissa (1995) attempted to use quarterly data from 1964 to 1990 and analyze the Granger causality between inflation, gross domestic product, exchange rate, foreign interest rates and foreign interest rates in Tunisia, Morocco and Egypt. The results showed that the increase in the money supply had only a positive effect on the inflation rate in Egypt and Morocco but had little effect in Tunisia. The study also found that expected inflation has a positive effect on inflation in all three countries. The impact of foreign interest rates has a positive impact on inflation in Tunisia and Morocco, but the latter has little impact on Egypt. Thus, according to Deme and Fayissa (1995), in Tunisia it is not monetary inflation but imported inflation.

Coutinho (2012) used the Generalized Method of Moments (GMM) for panel data of 11 Mediterranean countries over the period 1980-2009. He found that the budget deficit and the current account deficit positively affect inflation. That is, countries that suffer from a high budget deficit or current account deficit also suffer from high inflation. Moreover, Coutinho (2012) found that inflation is negatively related to unemployment for all the countries studied.

Khemiri and Ben Ali (2012) used the "Markov transformation" method to obtain monthly data on the Tunisian economy from January 2001 to December 2009. In their study, the two authors tried to use the following variables to analyze the determinants of inflation in Tunisia. These are: Consumer Price Index (CPI), Industrial Production Index (IPI), Average Money Market Interest Rate (MMR), value of imports, value of exports and nominal exchange rate. The results show that changes in the value of imports and the nominal exchange rate have a

positive impact on inflation in Tunisia. In addition, they also showed that Tunisian prices react quickly to changes in exchange rates.
Khemiri and Ben Ali (2012) also found that growth in the value of exports, industrial production index and the average money market interest rate had a negative impact on Tunisia's inflation Indeed, increasing value exports and industrial production indices increases the possibility of maintaining a low inflation system; on the other hand, increasing value imports increases the possibility of remaining in a high inflation system.
The 1990s saw a relatively widespread move towards independent central banks. The particularity of this evolution does not lie in the independence itself, but in its degree of diffusion. In fact, independent central banks have existed for decades, such as the German Bundesbank (1957) or the Swiss Bank (Cukierman, 1994). Therefore, central bank independence was the most common choice in the following countries: New Zealand (1990), Italy (1993) and France (1994). With the creation of the European Central Bank (ECB) (1999), the countries participating in the euro area had to adopt the central bank charter in line with the independence of the European Central Bank. The same trend was observed in Eastern European countries: Hungary (1991) and Russia (1993). Finally, emerging and developing countries are following the same trend at least in legal terms, sometimes under the advice of the International Monetary Fund (IMF). The legitimacy of independence is confirmed in the theory of inflationary bias.
Structuralists (Olivera, 1964; Argy, 1970; Wacher, 1976) have in turn tried to find the cause of inflation. They found that in this framework, inflation can be the result of structural imbalances in different markets (production, labour, money) or can be caused by institutional factors, restrictions when adopting monetary policies. Therefore, most studies focus on the independence of central banks in developed countries, as the main available indicators are based on legal aspects (Grilli et al., 1991; Desouza, 2001).
Thus, the governor of the central bank should be independent of the political power and the institution should be independent of the state and the political system, in order to increase the confidentiality and effectiveness of monetary policy and improve credibility. This assumption has been used and proven by Alesina et al (1993).
Edwards and Tabellini (1991) attempted to analyze the impact of political stability on inflation in 76 countries from 1971 to 1982. They introduced three indicators in their study, namely the actual frequency of power transfer, the possibility of power transfer and political weakness, which led to political instability. The results show that throughout the study period, political unrest played a key role in increasing inflation in 76 countries.
Fouda (1998) Based on the methods used by Grilli et al. 1991 and Cukierman (1992), proposes a set of measures for central bank independence in sub-Saharan African countries. He also analyses the relationship between central bank independence and the economic performance of a group of countries in the case of inflation for the period 1980-1993. It depends on the type of indicator and the sample selected.
Ahsen (2011) studied the relationship between central bank independence, inflation and governance. The study covered 36 Pacific countries from 1991 to 2005. This researcher used panel observation techniques to prove that there is a significant relationship between the central bank independence index (CBIG) and inflation. He uses (CBIG) six different agents: law, policy, price stability objectives, exchange rate policy, monetary policy and deficit financing, autonomy and transparency. All these indices allow him to indicate the fate and disadvantages of a particular central bank. He proved that after the 1997 crisis, central bank independence, reduced the inflation rate in these countries.

Aguir (2013) pointed out that the turnover of the central bank governor is a reliable indicator of central bank independence in low-growth countries. The coefficient is only meaningful when the sample includes countries with a high average inflation rate, i.e. countries with an inflation rate above 16.95%. The positive correlation between inflation and central bank independence was confirmed. He concluded that with more independence, we can achieve low inflation and ensure price stability in the long run.

The study by Ftiti, Aguir and Smida (2017) also traced the root causes of inflation. Thus, using panel data and income indicators as a proxy for CBI, the authors provide two main results. First, they determine the role of the exchange rate system in the dynamics between inflation and CBI. Second, their results show that in this relationship, only an intermediate and flexible exchange rate system is appropriate.

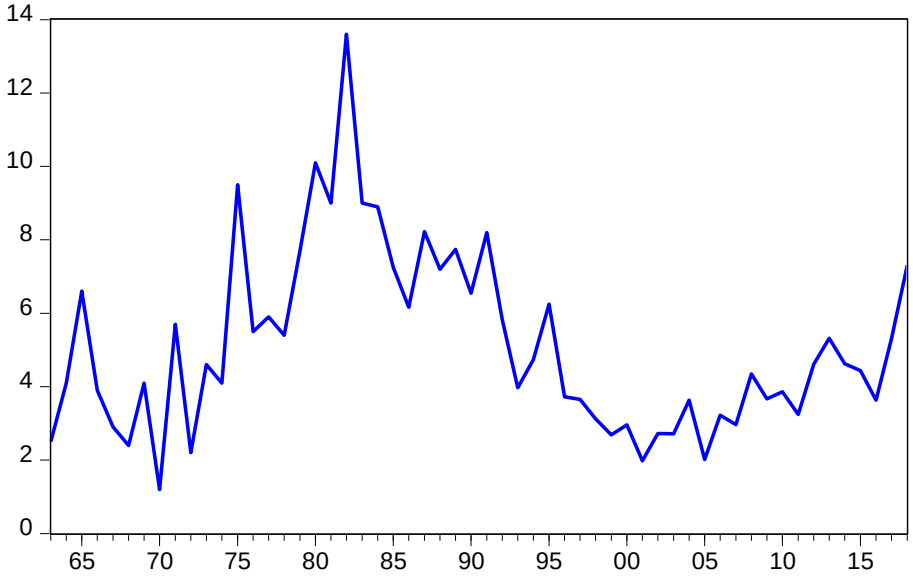
Several researches (Garriga 2016; Garriga and Rodriguez 2020) shows that CBI Legal has a negative impact on inflation in developing countries. Therefore, they prove that the policy independence of the central bank has a negative impact on inflation, which can be considered as controlling policies.

Simply using the concept of central bank independence, and as our work continues, we use a political indicator, namely the turnover rate of the central bank governor. Therefore, we will revisit this concept and link it to inflation.

2. Evolution of Inflation in Tunisia

The analysis of inflation in Tunisia since independence shows that this phenomenon goes through periods of stability and moments of fluctuation. The tendency is always upward and the inflation rate reached record rates.

Figure N01: Evolution of the inflation rate in Tunisia between 1963 and 2018



Source: Calculated from data of the Central Bank of Tunisia.

During the last six decades, inflation in Tunisia has remained more or less stable with an upward trend from one period to another. For the period between 1963 and 1972, the Tunisian economy was characterized by a more or less low inflation rate, which remained around an average of 3.56% along this period with a minimum of 1.2% obtained in 1970 and a maximum of 6.6% obtained in 1965.

Indeed, Tunisia has managed to control prices over this period and to lower the inflation rate following each remarkable increase.

It was with the first oil shock that the price level began to rise, increasing by 2.2% in one year, from 2.2% in 1972 to 4.4% in 1973, so the increase in oil prices on a global scale led to a reduction in demand and therefore in economic growth. Faced with this situation, Tunisia followed a policy of stimulating demand by increasing wages through an increase in foreign exchange. As a result of these policies, Tunisia managed to increase economic growth, but the cost was a rise in prices where the cost of living increased by 9.5% in 1975 compared to the previous year. However, during the period 1976-1978, Tunisia managed to maintain the upward trend in the growth rate and to reduce the inflation rate, which remained around an average of 5.6% during the three years (5.5%, 5.9% and 5.4% in 1976, 1977 and 1978). The decrease in the inflation rate was achieved mainly due to two factors. On the one hand, the increase in exports, where in 1978 the growth rate of exports exceeded that of imports for the first time since 1974. On the other hand, inflation was also reduced thanks to the interventions of the national compensation fund by subsidizing the prices of certain basic products.

The period 1979-1982 coincided with the second oil shock which led to an acceleration of the inflationary process where the inflation rate averaged 10.1% with a peak of 13.1% in 1982. This was explained by the rise in prices in the areas of services such as rent, leisure and transport and may reflect the impact of the oil shock. Moreover, this acceleration in prices was accompanied by an unfavorable economic climate, which amplified the damage of this phenomenon.

After 1982, the rate of inflation decreased, despite the existence of some social instability in December 1983. Inflation averaged 7.83% between 1983 and 1986, although the period between 1984 and 1986 saw a slowdown in the rate of inflation which can be explained by the economic recovery except for 1986. In addition, the slowdown in the rate of price changes can be explained by the improvement in productivity and the reduction in domestic demand through the implementation of a credit reduction policy. The growth rate of credits to the economy decreased by 12.4% between 1983 and 1986, from 22.8% in 1983 to 10.4% in 1986. It is true that after 1982 inflation fell remarkably, but it remained high at over 6%. Indeed, this high level of prices coupled with the maintenance of a fixed exchange rate regime reduced the competitiveness of the Tunisian economy on the international market, which led in 1986 to an unbearable deficit in the balance of trade of 517 million dinars according to the Central Bank of Tunisia. This situation led to the intervention of the International Monetary Fund and the adoption of a structural adjustment plan. Within this framework, several reforms were carried out by Tunisia such as the devaluation of the Tunisian dinar, the modification of the monetary policy and the liberalization of prices of certain products.

During the period between 1987 and 1991, the inflation rate remained more or less stable with an average of 7.48%. This stability was the result of the compression of public expenditure and the prudent wage policy.

It is from 1992 onwards that the inflation rate starts to decrease, recording a 2% drop compared to the previous year and fluctuating around an average of 4.83% between 1992 and 1994, but this situation did not last long since the inflation rate increased again to reach a rate of 6.3% in 1995. This increase was the result of the rise in the prices of certain basic products such as olive oil, the production of which has decreased for two consecutive years.

The period between 1996 and 2003 saw a drop in the inflation rate, which reached an average of 2.94% with a minimum value of 2% obtained in 2001. This reduction in the rate of price

growth is explained, according to the Central Bank of Tunisia in its 42nd report in 2000, by the restrictive monetary policy. This policy aims to ensure a rate of growth of liquidity proportional to that of wealth creation with appropriate financing of the economy. Moreover, the fall in the inflation rate is explained by the application of a prudent budgetary policy based on the rationalization of public expenditure, the improvement of the yield of the tax system and the regular satisfaction of the demand of the local market either by domestic or imported products, or by strategic stocks, by the encouragement of growth and the effectiveness of the control of economic activities and by the fact of defending the value of the Tunisian dinar and thus the competitiveness of the Tunisian economy.

The reduction in the inflation rate has contributed to the improvement of the economic situation by creating a favorable climate for private investment. It has also led to a reduction in interest rates, which has encouraged economic activity, job creation and stimulated exports. In addition, the decrease in the inflation rate contributed to the improvement of the competitiveness of the Tunisian economy on the international markets: the growth rate of exports increased from 2.2% in 2002 to 6.1% in 2003, and exceeded the growth rate of imports, which increased from 1.4 in 2002 to 3.9 in 2003. In addition, the improvement of competitiveness also leads to an improvement of the coverage rate, which reaches 73.7 in 2003.

From 2003 to 2011, inflation in Tunisia remains more or less stable and fluctuates around an average of 3.31% with a minimum rate of 2.02% obtained in 2005 and a maximum rate of 4.34% obtained in 2008. In fact, from 2011, the date of the outbreak of the Revolution, inflation in Tunisia began to follow an upward trend, rising from a rate of 3.24% to a rate of 7.31% in 2018. According to the Central Bank of Tunisia, the rise in the inflation rate is mainly due to the increase in the wage bill and the depreciation of the exchange rate, which increases production costs. In addition, the rise in prices can be explained according to the Central Bank by disruptions in supply and distribution channels as well as certain shocks on the prices of fresh products and illicit trade with neighbouring countries.

Faced with this situation, the Central Bank has tried to limit the rise in prices by several measures such as increasing the key rate, which was raised by 75 basis points in March 2018 and by 100 basis points in June, and by tightening bank liquidity. The inflation rate reached 5% in April 2021 compared to 48% the previous month.

Model and Choice of Variables

Model Variables

In our study, we explain the inflation phenomenon in Tunisia and its determinants along the period 1986-2019. In this framework we use the inflation rate as a dependent variable which will be explained by monetary variables such as the average money market rate (MMR) which represents the domestic interest rate and non-monetary variables which are the growth rate of GDP per capita, and the turnover rate of the central bank governor as a measure of the independence of the central bank. We use the annual variation of the exchange rate to detect external shocks as well as the rate of growth of Tunisia's imports

Table 1: List of Variables

Variable	Definition	Source
Inflation rate	It is the change in the consumer price index that measures the average cost of a basket of goods and services purchased by a consumer.	The World Bank
Gross Domestic Product	"Real gross domestic product, or volume GDP is a measure of GDP at constant prices. Changes in GDP due to price changes are neutralized, allowing a measure of economic growth.	The World Bank
Annual variation of the euro-dinar exchange rate	"It reflects the year-on-year change in the nominal euro/dinar exchange rate.	Fxtop company
Money market rates	It represents the rate at which banks lend money to each other.	The Central Bank of Tunisia
Budget deficit	"The deficit is calculated by subtracting total revenue (excluding grants and privatization) from expenditure (excluding debt repayment).	The Ministry of Finance of Tunisia
The turnover rate of the Central bank governor	we assign the value 0 in the case where there has been no change in the governor, while we assign the value 1 in the case where there is only one change. Then, we calculate the simple arithmetic average of these assignments over the estimated period for each year.	Kof Zurich
Import growth rate	"The term 'imports' in economics refers to all purchases of goods from outside a country, whether they are goods for consumption (consumer goods) or goods for investment (capital goods)." .	The World Bank
Credit to the private sector as a percentage of GDP	Domestic credit provided to the private sector refers to the financial resources provided to households and enterprises by financial enterprises in the form of loans, purchases of non-equity securities, trade credits and other claims.	The World Bank

Thus, our model will be presented in the following form:

Inflation = f (The turnover rate of the Central bank governor, real GDP growth rate, credit to the private sector as a percentage of GDP, exchange rate change, Money market rates, budget deficit, import growth rate)

Table 2: Expected Signs

Variables	Expected signs	References
Credit to the private sector as a percentage of GDP	(+)	Daniel (2006)
Budget deficit	(+)	Milo (2012) Zonuzi and al (2011)
Annual variation of the exchange rate	(+)	Deme and Fayissa (1995) Loungani and swagel (2001)
Money market rates	(-)	Khemiri and Ben Ali (2012) Adayleh (2018)
The growth rate of real GDP.	(-)	Asien and Veiga (2006) Hashim et al (2014) Darrat (1986) Khemiri and Ben Ali (2012)
The turnover rate of the Central bank governor	(+)	Aguir (2014) Cukierman and al (1992)
Import growth rate	(+)	Khemiri and Ben Ali (2012) Ayinde and al (2010)

Methodology

When dealing with time series, several problems have been encountered by researchers such as stationarity of the series and spurious regression. These problems have been addressed by the development of unit root tests (Dikey and Fuller, 1979; Augmented Dikey Fuller, Philips and Perron, 1988; Kwiatkowski et al., 1992), These tests detect the presence of a unit root. The problem of non-stationarity of the series can be solved by transforming the variable into a first difference. Another problem concerns the uncertainty about the existence of a long-term equilibrium relationship between the variables, known as cointegration. In this context, several techniques have been developed to test the existence of this relationship, such as the Engel-Granger cointegration test and the Johansen approach. However, it is important to note that these 'traditional' cointegration tests can only take into account the cointegration relationship between stationary series of the same order.

Pesaran et al (2001) managed to solve this problem through the cointegration test at the bounds of an ARDL model which allows to test the cointegrating relationship between variables which are not integrated of the same order provided that the order of cointegration is less than 2 (I(.)<I (2)).

The Autoregressive Distributed Lag (ARDL) model belongs to the family of dynamic models. The term autoregressive (AR) means that the dependent variable can be explained by its past values and the term staggered or distributed lag (DL) means that the dependent variable can be explained by the current and lagged values of the explanatory variables. Thus, the ARDL model represents a dynamic model in which the dependent variable will be explained by its lagged values and the current and lagged values of the explanatory variables, which can help researchers to take into account the maximum amount of information to improve the quality and credibility of their results.

The boundary cointegration approach was developed by Pesaran and Shin (1998) and extended by Pesaran et al. This approach has succeeded in solving the problem of the

incompatible order of integration between variables. That is, with this approach one can study the cointegration relationship between variables with different order of integration. Moreover, it allows the study of the short term relationship through the estimation of an error correction model (ECM).

Concerning the conditions for the application of the cointegration test approach to the bounds of an ARDL model Montenegro (2019) has defined three necessary conditions for the application of this approach: the variables used must not have an integration order greater than 2. That is, the variables used can either be integrated of the same order I (0) or I (1) or with a different integration order I (0) and I (1).

The dependent variable must be integrated of order 1 (I (1)). Many studies have not respected this condition although it has been cited by Pesaran et al (2001). According to Montenegro (2019) this condition is necessary to avoid the spurious cointegration problem.

In the long run only, the dependent variable follows the other variables and the relationship should not be reciprocal. That is, there is only one long-run equilibrium; in other words, only the dependent variable must respond to any deviation from this equilibrium.

Among the advantages of the cointegration test approach to the bounds of an ARDL model, according to Nkoro and Uko (2016), is the reduction of the endogeneity problem. Through the existence of a single cointegrating relationship, we can distinguish the dependent variable and the explanatory variables (as opposed to the VAR model). That is, this approach provides a single reduced form equation between the dependent and explanatory variables.

Through a simple linear transformation, the error correction model can be derived from the ARDL model. Indeed, this model allows the integration of short-term adjustments with the long-term equilibrium without losing long-term information.

In addition to the advantages cited by Nkoro and Uko (2016), we can add that: The cointegration test approach to the bounds of an ARDL model is more suitable for small sample sizes (Pesaran et al. 2001); on the other hand, Johansen's approach requires large sample sizes to have good results.

This approach also allows the study of the cointegration relationship between variables that are not integrated of the same order.

The cointegration test approach to the bounds of an ARDL model can also determine the number of lags associated with each variable as opposed to the VAR model which allows the same number of lags to be chosen for all variables.

In our situation, the ARDL model is written in long-run form as follows:

$$\begin{aligned}\Delta INF_t = \alpha_0 &+ \sum_{i=1}^{q} \alpha_{1i}\Delta INF_{t-i} + \sum_{i=0}^{p} \alpha_{2i}\Delta DEF_{t-i} + \sum_{i=0}^{p} \alpha_{3i}\Delta CRED_{t-i} + \sum_{i=0}^{p} \alpha_{4i}\Delta GDP_{t-i} \\ &+ \sum_{i=0}^{p} \alpha_{5i}\Delta IMP_{t-i} + \sum_{i=0}^{p} \alpha_{6i}\Delta MMR_{t-i} + \sum_{i=0}^{p} \alpha_{7i}\Delta TRG_{t-i} \\ &+ \sum_{i=0}^{p} \alpha_{8i}\Delta AVER_{t-i} + \beta_1 INF_{t-1} + \beta_2 DEF_{t-1} + \beta_3 CRED_{t-1} + \beta_4 GDP_{t-1} \\ &+ \beta_5 IMP_{t-1} + \beta_6 MMR_{t-1} + \beta_7 TRG_{t-1} + \beta_8 AVER_{t-1} + e_t\end{aligned}$$

With:

α_0: constant, from α_1 to α_8 : the short term coefficients with β: the long term dynamics,

Δ: first difference operator and e_t : error term .

INF: Inflation rate

CRED: Credit to the private sector as a percentage of GDP
GDP : Growth rate of real GDP per capita
IMP : Import growth rate
MMR: Money market rates
TRG: The turnover rate of the Central bank governor
AVER : Annual variation of the exchange rate

After the choice of the optimal model with the information criteria (Akaike, Schwars), the specified model is estimated with the ordinary least square method and then the cointegration test is carried out:

H0 :$\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = \beta_8 = 0$: no cointegration relationship

H1 :$\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, \beta_7 et\ \beta_8$ are not simultaneously zero : existence of a cointegration relationship.

The test consists in comparing the value of the calculated F-statistic with two critical values: the first is the lower bound value, which is established by assuming that all variables are stationary in level (I (0)) and the second is the upper bound value, which is established by assuming that all variables are stationary in first difference (I (1)).

It is important to note that in our study, the sample size is small (35 observations) which means that we cannot use the critical values of cointegration test bounds generated by Pesaran et al. (2001) which are generated for sample sizes of 500 and 1000 observations. To circumvent this problem, we will use the critical values generated by Narayan (2004) which are critical values generated for small sample sizes.

After the cointegration test at the bounds, we can estimate the short-run relationship which can be established through an error correction model (ECM) which takes the following form:

$$\Delta INF_t = \alpha_0 + \sum_{i=1}^{q} \alpha_{1i} \Delta INF_{t-i} + \sum_{i=0}^{p} \alpha_{2i} \Delta DEF_{t-i} + \sum_{i=0}^{p} \alpha_{3i} \Delta CRED_{t-i} + \sum_{i=0}^{p} \alpha_{4i} \Delta GDP_{t-i} + \sum_{i=0}^{p} \alpha_{5i} IMP + \sum_{i=0}^{p} \alpha_{6i} \Delta MMR_{t-i} + \sum_{i=0}^{p} \alpha_{7i} \Delta TRG_{t-i} + \sum_{i=0}^{p} \alpha_{8i} \Delta AVER_{t-i} + \delta ECM_{t-1} + e_t$$

Descriptive Statistics

Table 3: Descriptive Statistics

	INF	TRG	MMR	AVER	CRED	IMP	GDP	DEF
Mean	4.687373	0.200000	6.857179	5.232403	65.78387	5.604799	3.612349	3.787429
Maximum	8.225806	1.000000	11.81250	26.79501	86.23646	18.75158	7.949819	6.900000
Minimum	1.983333	0.000000	3.230000	-8.722911	51.43085	-13.04733	-1.917178	1.000000
Std. Dev.	1.837115	0.405840	2.431611	8.882616	9.191784	7.568888	2.426656	1.382496

According to the descriptive statistics, the inflation rate varies around an average of 4.69% with a maximum value of 8.2% reached in 1987, the year in which the country experienced remarkable political changes and the application of structural adjustment programs proposed

by the International Monetary Fund and the World Bank. The inflation rate reached its minimum value in 2001.

For the independence of the central bank, the average annual variation of the latter is equal to 0.2% with a maximum value of 1. The minimum value of TRG is equal to 0 .

The growth rate of imports varies around an average of 5.6% along the period studied; it reaches its maximum value equal to 18.75% in 2017. The minimum value of this variable is equal to -13.04% obtained in 1985.

Similarly, the Growth rate of real GDP per capita varies around an average of 3.61%, reaching its maximum value of 7.95% in 1990. We note that the only negative value was reached in 2011, the year of the Tunisian revolution, with a value of -1.91%.

The euro-dinar exchange rate in turn varies around an average of 5.23% with a maximum value of 26.79% in 1987 which reflects the impact of the delicate circumstances the country is going through during this period. This can also be explained by the results of the application of some of the conditions of the structural adjustment programs, which included a devaluation of the national currency. The variation of the exchange rate reached its minimum value in 2000, which corresponds to a negative variation equal to -8.72%. It is clear that the Euro-Dinar exchange rate experienced a strong fluctuation during the period under study, which is justified by the high value of the standard deviation, which is equal to 8.88. It should be noted that the dinar-euro exchange rate evolved by 251.43% between 1987 and 2018, from 0.88 dinar for one euro to 3.1 dinar. Moreover, we note that the Tunisian dinar lost 58.21% of its value against the euro between 2010 and 2018, going from 1.96 dinar for 1 euro in 2011 to 3.1 in 2018.

For the average money market rate (MMR), the average of the values of this variable between 1985 and 2019 is equal to 6.85%. The MMR reaches its maximum value in 1990 and its minimum value of 3.23 in 2011, which may reflect a monetary expansion in that year. Indeed, the Central Bank of Tunisia has tried to restore confidence in the banking system by making it easier to obtain liquidity, which justifies the reduction of interest rates.

Empirical Results

Stationarity Study

To check the stationarity of the variables we will refer to the ADF test, the results are as follows

Table 4: Stationarity test

Series	Tests ADF (Probability)		Order of integration
	Level series	1st difference series	
INF	0.9944	0.0001	I(1)
TRG	0.0002	-	I(0)
MMR	0.3702	0.0000	I(1)
IMP	0.0001	-	I(0)
AVER	0.0001	-	I(0)
GDP	0.0000	-	I(0)
DEF	0.0278	-	I(0)
CRED	0.0735	0.0000	I(1)

By studying the stationarity of the series used with the help of the Eviews 9.5 software, we note that the inflation rate, the Credit as a percentage of GDP and the MMR are stationary in first difference. On the other hand, the rotation rate of the central bank governor, the growth rate of imports, the annual variation of the exchange rate, the budget deficit and the growth rate of real GDP are all stationary in level.

The study of stationarity shows that the variables used are not stationary of the same order, which confirms our choice to use the boundary cointegration test approach to study the cointegration relationship between the variables. Moreover, we recall that the inflation rate which represents the dependent variable is stationary in first difference and we also note that all the variables have an integration order lower than 2, which means that the first two conditions of the application of the cointegration test approach to the bounds of an ARDL model have been respected.

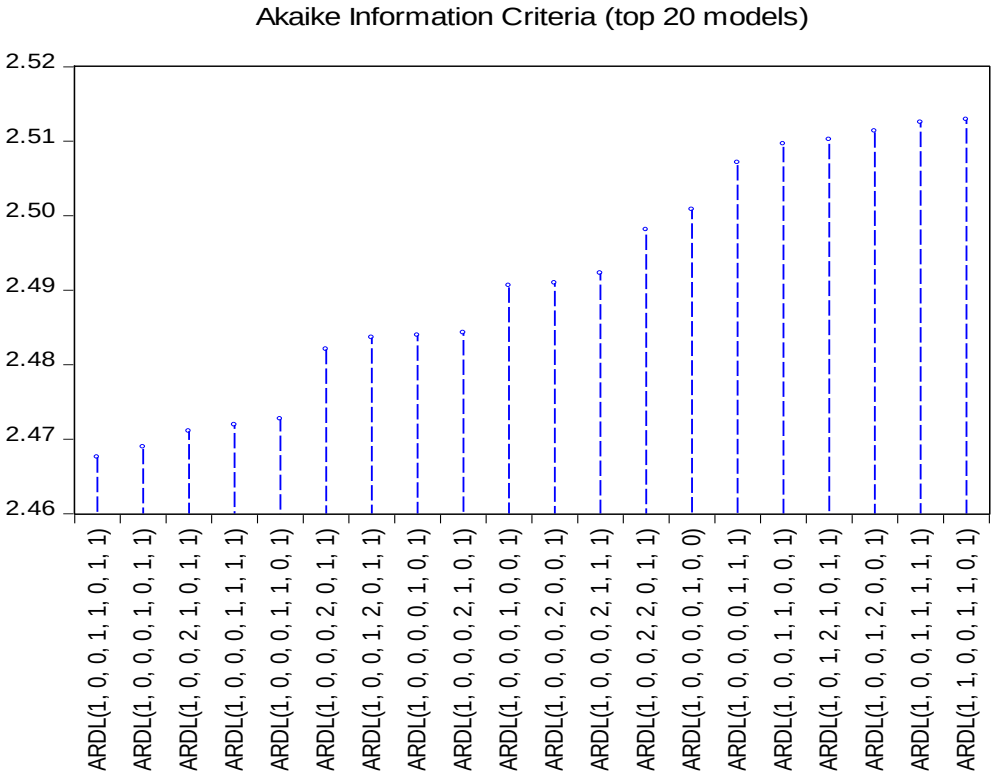
Model Estimation

- Optimal Delay Selection

The optimal lag of each variable will be realized based on the Akaike criterion and with a number of lags equal to 2 as recommended by Pesaran (2001) and Narayan (2004), the optimal lag being the one that minimizes the Akaike function. The Eviews software offers us the possibility to estimate an ARDL model in an automatic way and gives us the optimal lag associated to each variable.

Thus, our optimal model is: ARDL (1.0.0.1.1.0.1.1). The number of optimal lags is 1 for the variables INF, GDP, TRG, AVER and IMP; 0 for DEF, CRED and MMR.

Figure 2: Optimal model selection



- Bounds cointegration test

Table 5: F-statistics

Statistical test	Value	K	N
F-statistic	4.341019	7	35

Table 6: Bounds cointegration test

Significance	Lower bound I(0)	Upper bound I(1)
1%	2.73	3.9
2.5%	2.43	3.51
5%	2.17	3.21
10%	1.92	2.89

By comparing the value of F-statistic, which is equal to 4.34, with the critical values of F-statistic, we see that this value is higher than the critical values for the 1% thresholds. We therefore reject the null hypothesis and accept the alternative hypothesis of the presence of cointegration for the said thresholds. This means that there is a long term equilibrium relationship between the inflation rate and the explanatory variables used.

The results of the estimation of the short-term coefficients are shown in the following table:

Table 7: Error correction model and short-term dynamics

Series	Coefficient	Erreur std	t-statistic	Probability
D(TRG)	0.695175	0.238180	2.918697	0.0082^{***}
D(MMR)	0.712051	0.135905	5.379093	0.0000^{***}
D(AVER)	0.064145	0.011925	5.379093	0.0000^{***}
D(CRED)	0.063741	0.025543	2.495469	0.0210^{**}
D(IMP)	0.012378	0.012670	0.976980	0.3397
D(DEF)	0.073589	0.094554	0.778269	0.4451
D(GDP)	-0.082842	0.038440	-2.155109	0.0429^{**}
ECM_{t-1}	-0.974483	0.126016	-7.733014	0.0000
	R^2=0.899	R^2 adjusted = 0.841		SCE : 0.719582
	DW=2.084	F-statistic=15.62591		SCR :10.87375

The below table provides us with the estimated long-term coefficients.

Table 8 : Long-run relationship

Series	Coefficient	Std. Error	t-Statistic	Prob.
TRG	1.123766	0.495597	2.267500	0.0340**
MMR	0.567349	0.066798	8.493444	0.0000***
AVER	0.106555	0.024341	4.377562	0.0003***
CRED	0.057970	0.020255	2.861977	0.0093***
IMP	0.046487	0.025267	1.839784	0.0800*
DEF	0.095645	0.116866	0.818411	0.4223
GDP	-0.136922	0.094938	-1.442229	0.1640

Model Robustness Tests

a. Error normality test: Jarque-Bera :

Table 9: Jarque-Bera test

Test	Probability
Jarque-Bera	0.597153

The probability of the Jarque-Bera test is well above 0.05%, so we can say that the residuals follow a normal distribution and we can continue the robustness check of our model.

b. The Error Autocorrelation Test

Several tests can be used to test the autocorrelation of errors such as the Ljung-box, the Durbin-watson test, the Breusch-Gofrey test... In our case we use the Breusch-Godfrey test, which is the most used for ARDL models.

The decision rule is to accept the null hypothesis of no error autocorrelation if the test probability is greater than 5%.

Table 1:Test Breusch-Godfrey

Test	Probability
Breusch-Gofrey	0,6235

We note that the test probability is equal to 0.6235 greater than 5%, so we accept the null hypothesis of no error autocorrelation and can therefore proceed to the other robustness tests.

c. Heteroscedasticity Tests

To test for heteroscedasticity, we use the ARCH and the Breusch-Pagan-Godfrey test, both with the same decision rule and the same assumptions:

H0: homoscedasticity

H1 : heteroscedasticity

Table 2:Tests ARCH et Breusch-Pagan-Godfrey

Test	Probability
ARCH	0.7861
Breusch-Pagan-Godfrey	0.7329

The probabilities of both tests are greater than 5% and we therefore accept the null hypothesis of homoscedasticity and can proceed to the next test.

d. Stability tests of the CUSUM and CUSUM of Squares coefficients

The CUSUM test is based on the sum of the residuals, which is represented by a curve that must fluctuate in the critical zone for the model to be stable.

The same principle applies to the CUSUM of Squares test, which is based on the sum of the square of the residuals.

Figure 3: The CUSUM Test

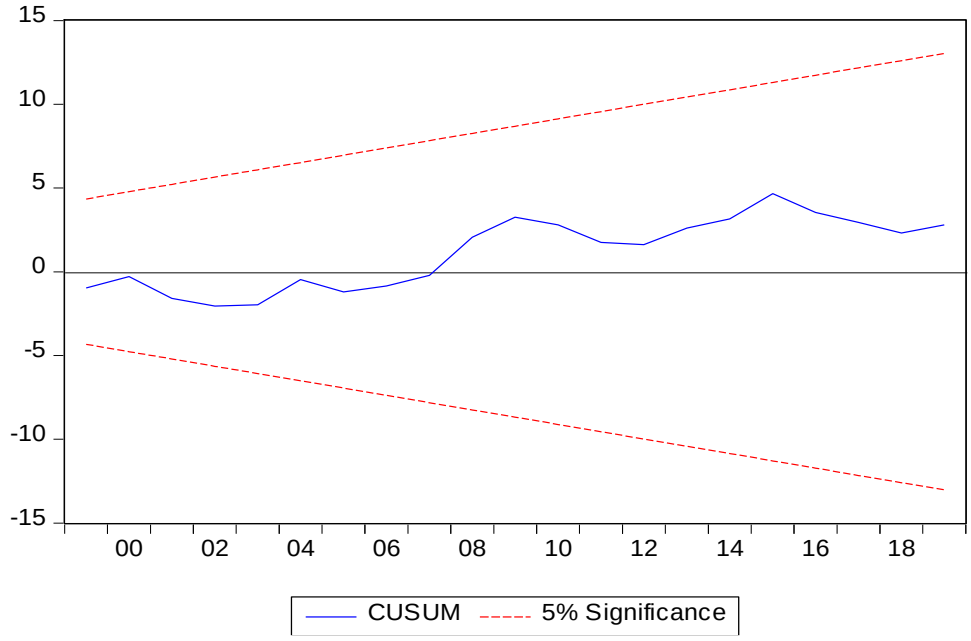
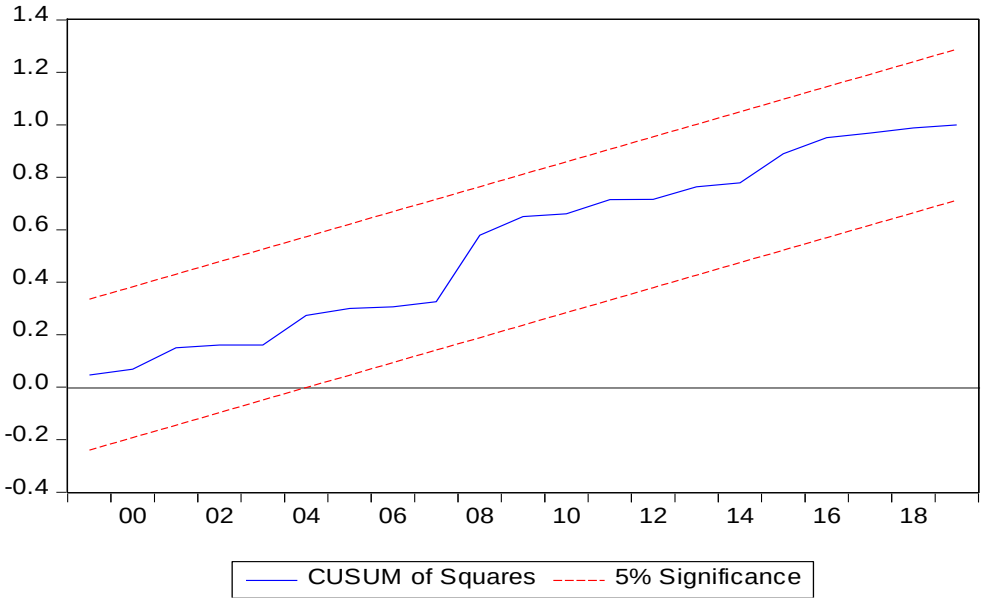


Figure 4: The CUSUM of Squares test



According to the two graphs, we accept the null hypothesis of stability of the relationship for a threshold of 5%.

Interpretation and Discussion

Table 7 shows that the error correction term ECM_{t-1} is negative and highly significant (for a threshold of 1%), which confirms the results obtained by the cointegration test within the limits of the existence of a long-term equilibrium relationship between inflation and the chosen explanatory variables. The value of the adjustment coefficient is equal to -0.97, which means that the deviation of the inflation rate from the long term equilibrium will be corrected by 97% in the following year.

The coefficient of determination R^2 is equal to 0.899, which means that 89.9% of the variation in inflation is explained by the explanatory variables used.

It is true that the Central Bank of Tunisia became independent in 2016, which eliminates the possibility of recourse to finance the deficit, but before 2016 recourse to the central bank was

among the solutions to finance the budget deficit, especially after the Revolution. In this context, it is important to note that despite the independence of the Central Bank, Boulila (2017), states that the central bank will be able to sell treasury bills to banks at high rates compared to foreign loan rates. In this framework, it will be able to indirectly finance the budget deficit.

Concerning the independence of the central bank in the short run this variable is significant at the 1% threshold in the short run and at 5% in the long run. With a sign that is consistent with our expected sign.

This result is confirmed by the existing literature by several works (Cukierman 1992; Vazques 2008; Posso and Tawadros 2013; Aguir 2013; Martin 2015; Aguir 2018; Ftiti et al. 2017)

The impact of independence of the central bank in Tunisia has two fundamental goals which are the stabilization of the price system and financial stabilization.

Thus, since its independence in 2016, the BCT has slowed down the spread of inflation through its important role in the Tunisian economy because from the beginning of its creation, the monetary authority has played the role of lender to the economy, since it was based on bank loans for public or private investments granted by commercial banks. Thus, the political authorities benefit from the central bank, according to their own interests.

Therefore, according to our results, central bank independence can reduce inflation in the short run and even more so in the long run given that Tunisian inflation is a composite inflation of multiple forms.So the real independence of the central bank can be a solution to fight inflation. It is also necessary to have policies adjacent to it such as import control, encouraging investment by controlling interest rates... .

Concerning the variation of the nominal exchange rate, we note that the impact of the latter on inflation is proven in the short and long term. In the short term, the coefficient of the exchange rate is positive and significant for a threshold of 1%; as well as in the long term. The impact of the exchange rate variation in the long term is more interesting than in the short term.

Thus, the results obtained confirm others such as (Darrat 1986; Deme and Fayissa 1995; Khmiri and Ben Ali, 2012) who conclude that inflation is positively related to the exchange rate variation.

Indeed, a depreciation of the Tunisian dinar increases the prices of imported goods which will increase the prices charged on the domestic market. This impact will be reinforced by the increase in the rate of imports and the worsening of the trade deficit, which reaches 17.9 in percentage of GDP, with a coverage rate of 68.3% in 2018 according to the Central Bank of Tunisia.

Moreover, a large part of Tunisian imports represent energy products and raw materials which are generally inelastic to exchange rate variations. These products depend on the needs of the population and industries, or on equipment which is too expensive compared to our exports which generally represent agricultural products with low added value.

The impact of the MMR on inflation is positive in the short and long term with a significant coefficient for a threshold of 1%, but we find that the reaction of inflation following the variation of the latter is weaker in the long term. These results are not consistent with the expected signs and do not confirm the results of Khmiri and Ben Ali (2012) who find that the MMR negatively affects the inflation rate in Tunisia. But the results obtained are found to be consistent with several empirical studies such as (Tran 2018; Greenige and Da Costa, 2009, Bayo, 2011)

Indeed, these results can be explained by the so-called price puzzle where the increase in interest rates will be accompanied by an increase in prices.
According to Balke and Emery (1994), there are two explanations for this phenomenon. The first is that of Sims (1992) where the central bank responds to expectations of rising prices by raising interest rates in the hope of curbing the expected rise in prices, but the rate increase will not be sufficient and inflation will still rise. For example, if the central bank expects prices to rise by 2% and therefore believes that it must raise interest rates by 1% to offset the rise in prices, but in fact prices are rising by 3% and therefore inflation will rise by 1%. This means that the increase in interest rates does not cause a price increase in this situation, but neither does it completely cancel the expected price increase; it only reduces the expected price change. This anticipation error can be linked to a wrong specification of the reaction function of the Central Bank, this function does not include all the factors that can affect inflation or a very rapid variation of prices that will always be higher than the expectations of the Central Bank.
In Tunisia, this explanation may be logical, especially after the Revolution, since several factors can be identified that can affect inflation, such as disruptions in the distribution channels, the continuous increase in the price of imported raw materials, the insufficient supply for certain products, etc. Furthermore, we note that prices vary rapidly - especially in the last three years - which can make the expectations of the Central Bank erroneous, which would have increased the key rate in the hope of preventing the realisation of expectations of price increases.
The second explanation is presented by Balke and Emery (1994), when the central bank responds to a supply shock by raising interest rates, but not enough to absorb the inflationary consequences of this shock.
Another explanation for the positive relationship between interest rates and inflation is presented by Blanchard (2004) who believes that the increase in the interest rate increases the risk of default, which makes the domestic debt less attractive for the government and leads to a real depreciation, which positively affects the variation of prices.
Blanchard (2004) argues that raising interest rates to reduce inflation is not a good solution in the presence of high levels of debt. Thus, when a large part of the debt is dominated by external debt and in the presence of a high degree of aversion on the part of foreign investors, increasing interest rates will not be able to reduce inflation, which is almost the case in Tunisia. So based on the conclusions of Blanchard (2004), we can say that the recourse to the increase of interest rates to reduce inflation in Tunisia does not constitute the good solution.
In this framework, Favero and Giavazzi (2004) believe that in the presence of a risk of default, monetary policy is ineffective in reducing inflation and fiscal policy is recommended to fight inflation.
For the growth rate of GDP per capita, we find that in the short term its coefficient is significant for a threshold of 5%. These results confirm the results of Darrat (1986) who also finds that the growth rate of real GDP negatively affects the inflation rate in Tunisia. This relationship can be explained by the fact that an increase in the cost of production due to an increase in taxes, wages or an increase in the price of imported goods leads to a decrease in production and an increase in prices.
The coefficient on private sector credit as a percentage of GDP is significant in the short and long run at the 5% and 1% thresholds respectively, with a positive sign and a slightly larger value in the short run. This indicates that an increase in credit to the private sector automatically leads to an increase in the general price level. Indeed, credit to the private

sector includes credit granted to companies and households. For enterprises, credit can be directed towards activities of production of goods and services which can cancel or at least cushion their impact on the general price level. However the problem generally lies with credits granted to households, which are generally consumption credits. This type of credit can widen the gap between the growth rate of the money supply and that of production. Indeed, consumer credit leads to an increase in demand compared to supply, which in turn leads to an increase in prices, so it is a question of inflation by demand, but it is of monetary origin.

Conclusion

Inflation in Tunisia is a complex phenomenon that results from several causes that can be monetary and non-monetary.

In Tunisia, the determinants of inflation have been the subject of several works (Darrat 1986; Deme and Fayissa 1995; Khemiri and Ben Ali 2012) ... Howether with the persistence of this phenomenon in Tunisia, we tried to detect the determinants of inflation in our country and to verify the existence of a relationship between the latter and the independence of the central bank and that of the import which are two phenomena which are experiencing a remarkable evolution. In fact, we have managed to detect some determinants of inflation by following a well-defined approach.

Firstly, we carried out a theoretical analysis in which we identified the phenomenon of inflation as well as its causes and consequences on the economy. Within this framework, it has been found that inflation is a complex phenomenon. It is according to theoretical investigations caused by several factors such as monetary variables, production costs, demand in the economy and structural factors related to persistent imbalances and the quality of institutions. Indeed, economic facts have shown that inflation is an evil for the economy and especially in the case of a higher rate. In addition, we carried out a descriptive analysis of the evolution of inflation in Tunisia. We found that prices have gone through periods of stability and periods of fluctuations which were generally accompanied by exceptional circumstances.

Finally, we tried to detect the causes of inflation in Tunisia and to verify the existence of a relationship between central bank independence and this phenomenon in Tunisia. In this case, we first reviewed the empirical literature, which synthesizes the results of several empirical works on the determinants of inflation in Tunisia and in the world, as well as works concerning the relationship between the two. Then, we tried to determine the source of inflation in Tunisia through the ARDL model by including monetary variables, such as the evolution of nominal exchange rates and non-monetary variables, the rotation rate of the central bank governor and the growth rate of real GDP per capita.

As a result, we found that inflation in Tunisia is essentially explained by the variation of exchange rates, the TRG, the credit granted to the private sector and the variation of interest rates which exerts a perverse effect. In this context, the analysis of inflation in Tunisia allowed us to show that this phenomenon is difficult to be explained by only monetary variables. Moreover, we found a surprising result represented by the existence of a positive impact of interest rates on inflation. However, this result is consistent with several others (Balke 1994; Blanchard, 2004; Favero and Giavazzi, 2004) who explain this relationship either by the behavior of the central bank or by the presence of a high debt ratio.

Contribution of Research and Recommendation

Through this study, we specify another cause of inflation in Tunisia, which is imports. This variable positively affects inflation in the long run. These results show that short-term inflation in Tunisia is essentially monetary and demand-driven inflation. While in the long run inflation is also the result of structural factors that can be represented either by structural imbalances in the different markets, labour, production, or currency, or by problems related to the quality of institutions or corruption.

Indeed, economic actors in Tunisia must cooperate to launch policies and reforms that aim to

- Create a committee comprising representatives of the Central Bank and ministries with economic competences in order to combine efforts and visions in terms of economic policies.
- Reducing imports and establishing barriers to the entry of products that are not needed and stimulating exports and the productive system.
- Encouraging national investments to improve the substitution effect

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