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The Response of Industrial Production to the macroeconomic factors: New Evidence for Tunisia

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ABSTRACT

This paper examines the macroeconomic factors-industrial production nexus in Tunisia by using the cointegration test. In addition, the functions of impulse responses is used to examine the impact of oil price, oil price uncertainty, stock market index, inflation rate, interest rate, and the Economic policy uncertainty on industrial production growth. Quaterly data from 2010 to 2021 are utilized. Empirical results reveal that there is a long-run relationship between industrial production and variables that reflect different macroeconomic factors. The shocks to lending rate, crude oil price, and the oil price uncertainty affect negatively industrial production in the long term. Also, we find that Industrial production adjusts in the long run to shocks to price level, stock market index and international environment. These findings give some policy implications. To combat this monetary inflation, interest rates would have to be raised to reduce inflation, Tunisia may build up oil security stocks that they can make available to reduce the impact of a temporary shortage or a significant price increase. A longer-term solution is to adopt renewable energies. These considerations lead us to conclude that better governance is necessary for the Tunisian economy to claim resistance to the various shocks that could come from the national or international environment..

Keywords: Industrial production, Oil price shock, Oil price volatility, Economic policy uncertainty, Stock market index, Cointegration, Functions of impulse responses.

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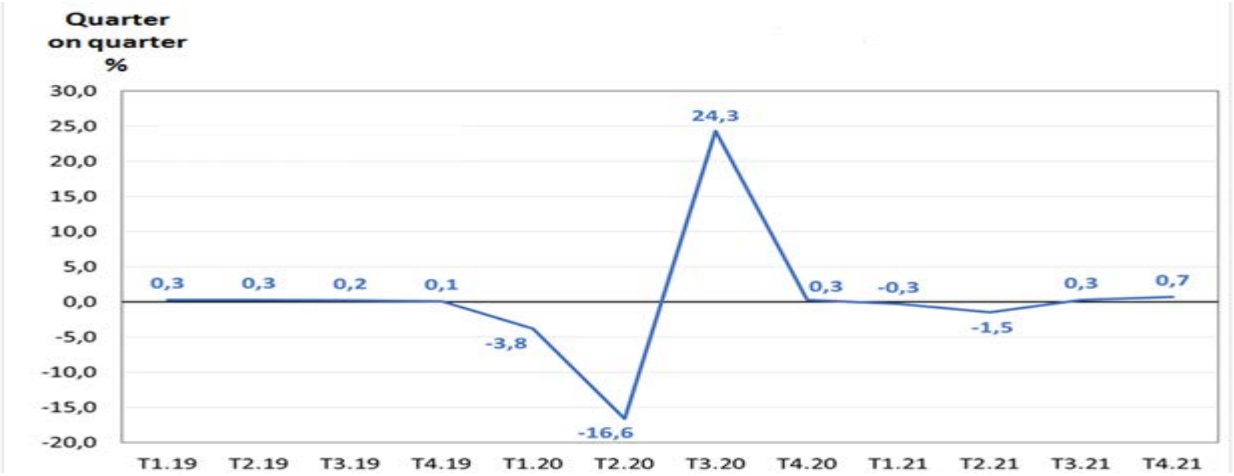
Introduction

Tunisia has entered the already very fragile health crisis, handicapped by many structural obstacles, which political instability since the revolution has not allowed to lift. The average annual growth rate rose from 4.3% in the 2000s to 1.7% in the 2010 decade, with the current account deficit ranging from 2% to 6% of GDP to 8-11%. The decline in productivity and investment, from 25.4% to 17.8% of GDP between 2010 and 2019, weakened Tunisia's growth potential and competitiveness, weakening its external balance. The economy remains highly dependent on household consumption (73% of GDP), which is not very diversified and exposed to the cyclical hazards of the agricultural sector (9% of GDP) or tourism (5% of GDP, but up to 14% of GDP indirectly). The importance of a plethora of administrations and inefficient public operators is a powerful brake on investment and the development of a competitive industry. The deterioration of the situation of about 100 state-owned enterprises representing more than 10% of GDP and 100,000 jobs is particularly worrying.

After a historic recession, the current pace of recovery would not allow a return to the pre-crisis level of activity before 2024. The Tunisian GDP growth rate reached 3.1% in 2021 according to the INS, after a fall of 8.7% in 2020. The recovery was held back in 2021 by continued restrictions imposed by the health crisis. The gross investment and savings rates already considered insufficient, collapsed respectively to 10.8% of GDP and 4% of GDP in 2020. Since then, Tunisia's political instability and high funding needs have been holding economic prospects back: the latest 2022 growth projections are at 2.6% according to the Central Bank of Tunisia. If the industrial sector benefits somewhat from the European recovery, phosphate production resumes and oil production benefits from the exploitation of new sites, services continue to suffer from the consequences of the health crisis. The agricultural sector, resilient in 2020, also experienced poor performance in 2021, with a decline in exports throughout the year. The Russian-Ukrainian crisis is further hampering growth prospects (loss of purchasing power, slowdown in European demand, drying up of Russian tourism, etc.).

Figure 1: Growth rate of the GDP in Tunisia (Quaterly data from 2019 to 2021)



Source: NIS (2022)

Inflationary pressures are re-emerging, while the deterioration of the social and employment situation is continuing tensions. Inflation rose from 4.9% at the end of 2020 to 6.7% in January 2022, fuelled by both global price pressures and the evolution of administered prices, particularly affecting food prices. Inflationary pressures are also reinforced by the Russian-Ukrainian crisis through the rise in international energy prices and largely imported agricultural products. Social indicators deteriorated sharply during the crisis and barriers to employment increased, fuelling frustrations: the poverty rate rose from 14% to 21% in one year and the unemployment rate reached 18.4% of the working population, the highest unemployment rate since 2011, with over 42% among young people. Witnessing the deterioration of the social situation, demonstrations for wage claims and employment have multiplied since 2020, especially in the south and interior of Tunisia, which are heavily affected by precariousness.

The importance of the energy in the development of the economies cannot be ignored owing to the rise in population in the world. Since energy consumption have a significant contribution to the economic growth. This has been quite evident with the unexpected upsurge in oil prices (Hamilton, 2012) and reducing the supply of the oil by OPEC countries due to political aims that has negatively influence not only developing but also the developed countries particularly the United States with low domestic output. Additionally, the dependence of the countries on energy cannot be ignored as the energy contributes to the economic growth significantly (Kirca et al. 2020). This has caused significant devastating effects to the developed economies by using energy as the political weapon (Ediger and Berk, 2011) as cited in (Kirca et al. 2020).

In this situation, we question the impact of certain macroeconomic variables and indicators on industrial production. Some reflect international conditions (oil price, international uncertainty related to major economic and geopolitical events, and volatility in oil prices), while others reflect domestic conditions. (Inflation rate, interest rate, stock market indice). We will study the impact of the various shocks affecting these factors on industrial production in Tunisia. Particularly, we will examine whether oil price and oil price volatility exert any significant impacts on the growth rate of industrial production. Tunisia is a small emerging market economy that is heavily dependent on the imports of crude oil, and thus the economy might be vulnerable to changes in the price of oil.

The rest of the study has been outlined as follows. Section 2 presents a summary of the previous literature. The methodology and model estimation will be discussed in section 3. Discussions and results are presented in section 4, while the study is concluded in section 5.

1. Previous Studies

Energy prices, interest rates, economic uncertainty and the stock market index nexus carries a key significance for to policy makers, because the mastery of these macroeconomic factors requires the implementation of appropriate policies to promote economic growth. As a result, it has received great concern among economists and investors.

1. GDP and interest rate nexus

One of the main objectives of the Central Bank in Tunisia (BCT) is to support growth while controlling inflation, which is becoming a major concern. To cope with this inflation trend, the BCT has used the main tool to increase the key interest rate to reduce the money supply issued through loans.

Rising real interest rates to exceptionally high levels, their sustainability at values between 5 and 10% since the revolution is the major characteristic of the recent period and is one of the keys to interpreting economic developments since 2011.

The increase in the key interest rate of the Central Bank of Tunisia (CBT) resulted in a slowdown in economic growth and a worsening of inflation in view of the weak development of the industrial production index.

A number of studies exist in the literature which have investigated the association between interest rate and the growth of economy. For example, Guillard M. & Rajhi (1994) developed an endogenous growth model that establishes a causal relationship between the risk-free interest rate and the rate of income growth. This relationship reflects the presence of a substitution effect in the investor's asset portfolio, between risky loans to companies and certain securities issued by the State. An increase in the certain rate reduces "productive" saving, private investment and, consequently, the production of physical capital and the rate of growth of the economy. The existence of a negative correlation between interest rates and income has already received a number of empirical validations, including on American data, by Sims [1980], Litterman and Weiss [1985], Stock and Watson [1989], Farmer [1990], Bernanke and Blinder [1992] and Gertler and Gilchrist [1993].

The real interest rate influences the behaviour of enterprises in a more complex way than it appears to be solely concerned with its impact on investment demand. Indeed, it is not only the decisions of accumulation, the main object of analysis of the theories of growth of equilibrium, but all the components of the costs and all the demands of factors that are affected, in the short term and in the longer term.

The real interest rate, which for the enterprise is a given, occurs at two distinct levels in this economic calculation:

- on the one hand it is a component of factor cost, a major and generally well-known component of the cost of using capital, but also, directly and indirectly, a component of labour costs;
- on the other hand, the real rate is also the discount rate used by the enterprise in calculating the present value of its future profits.

The direct impact of an increase in real interest rates is therefore both an increase in the cost of using factors and an effective shortening of the time horizon of the company's calculation: because a higher discount rate implies that future gains or losses weigh less in the present value of the company's expected profit. High real rates also have indirect consequences for employment and the relative prices of the factors of production, which result from their impact on factor demand and depend on the structure of the markets.

2. *Inflation and GDP*

Recent medium-term forecasts have revised upward the future trajectory of consumer prices. They expect an average inflation rate of 6.8% in 2022 before easing to 5.6% in 2023, after recording 5.7% in 2021 (see Table 1).

Table 1: Development of the Inflation rate (annual mean) (in %)

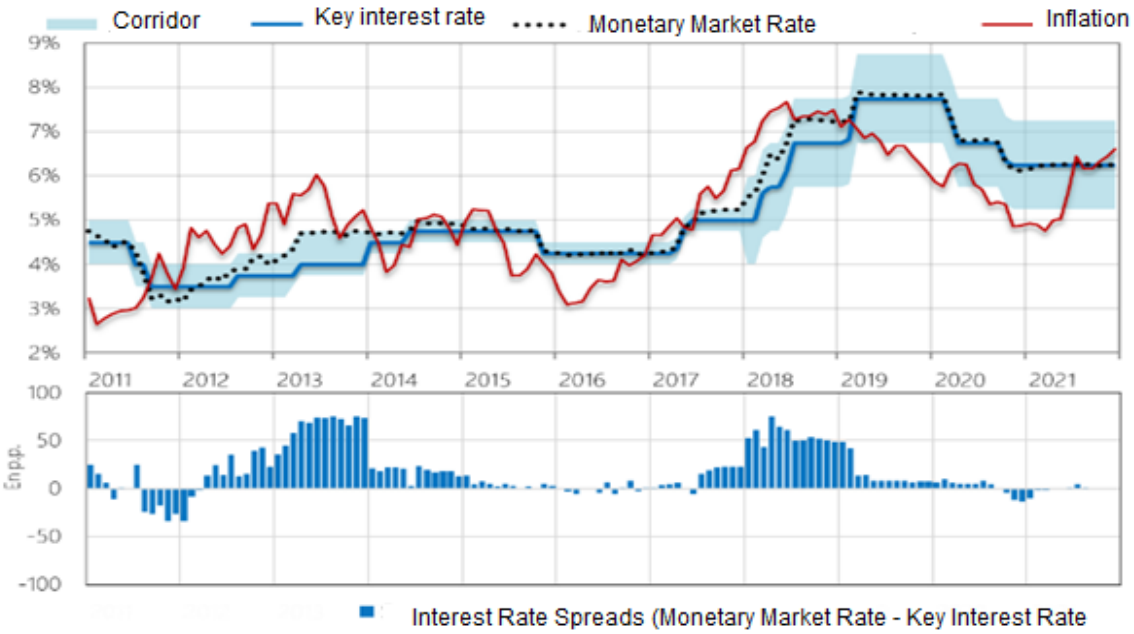
	2020	2021	2022	2023
Inflation	5,6	5,7	6,8	5,6
Core inflation*	5,6	5,4	6,4	6,1
Inflation of administered products	5,7	5,8	6,3	4,5
Inflation of fresh food products	5,9	7,1	9,4	5,4

(*) Inflation excluding fresh and administered food

Source: CBT (Central Bank of Tunisia) (2022)

To cope with this inflation trend, the CBT (Central Bank of Tunisia) has used the main tool to increase the key interest rate to reduce the money supply issued through loans. As a result, the key interest rate has evolved as follows:

Figure 2: Evolution of Interest and Inflation rates (in %)



Source: **CBT** (Central Bank of Tunisia) and **NIS** (National Institute of Statistics of Tunisia).

One of the main objectives of the majority of central banks around the world is the search for price stability. In spite of the plurality of objectives, price stability has emerged and has been imposed by solid theoretical and empirical work [Kydland et Prescott, (1977); McCandless et

Weber, (1995)]. Controlling inflation helps to increase the growth potential of an economy. However, low inflation can have counterproductive effects (Vinayagathasan, 2013). Central banks therefore face a real challenge in balancing low inflation with high economic growth (Ibarra and Trupkin, 2016). This dilemma is most pronounced in developing countries (DCs) and especially African countries, which have recorded positive growth rates over the past two decades.

To this end, several studies have attempted to determine an optimal inflation rate by highlighting the existence of a non-linear relationship between inflation and economic growth, confirming the existence of an optimal inflation threshold to ensure sustained and sustainable economic growth. This question is very important because in low inflation, inflation positively affects economic growth. On the other hand, in the high inflation regime, the increase in inflation would be counterproductive. These analyses are in line with a number of empirical studies and offer several lessons. The first is to give empirical content to the choice of inflation target. Indeed, by choosing a sub-optimal target, monetary authorities deprive governments of a lever for economic growth. However, any monetary decision to increase the inflation target will have to take into account, on the one hand, the credibility of such an action. On the other hand, the decision will have to include aspects related to the competitiveness of economies.

3. GDP and Crude Oil price nexus

Oil is initially considered as a production factor or an intermediate good used in a production process with a fairly complex technological composition. It is also considered as an end product to be consumed by the use of equipment with different yields depending on its user and its use. The impact of an exogenous shock on the economy needs to be analysed in terms of how it affects both spheres of the economy (upstream and downstream) assuming links between the two.

Theoretically, the impact of the fall in the price of oil on the economy is mainly through two transmission channels, purchasing power and producer prices of goods and services. However, the empirical link between the behaviour of Tunisian economic activity and negative oil price shocks is somewhat more complex for four reasons: (i) Tunisia adopts an administered price structure (ii) demand growth in trading partner countries is weak (iii) considerable uncertainties about maintaining low oil prices (iv) the availability of external financing.

Further studies have documented that oil prices significantly impact GDP. For instance, in one of the recent studies by Kirca et al. (2020) investigated the oil-gas prices effects on economic growth in Turkey by using Granger (1969) and Toda-Yamamoto (1995) causality tests with structural breaks and the frequency domain causality tests. The study confirmed the effects of the oil-gas prices on GDP is permanent and lasts for approximately five years. The study further recommended that Turkey must search an alternative avenue of energy to enhance the performance of key indicators of macroeconomic in the long run.

Jiranyakul K. (2017) examines the oil price-industrial production nexus in Thailand by using multivariate cointegration test in Thailand using monthly data from 1993 to 2015. The main results found show, first of all, that industrial production is cointegrated with the price of oil and that there is a stable long-term relationship between economic activity in a manufacturing sector and the real price of oil. Secondly, the impact of an oil shock on industrial production growth is not observed in the short term and there is no asymmetry and non-linear relationship between the oil price shock and production growth. Finally, the uncertainty of oil prices does not affect the growth of industrial production.

4. GDP and Crude oil Volatility nexus

With a little hindsight, it appears that oil prices are increasing tendentiously but that they remain subject to high volatility in the short term. This combination of an upward trend and high volatility is likely to continue in the coming years. Moreover, experience has shown how difficult it is to predict the evolution of the price of oil. Phases of pessimism and optimism follow one another, sometimes emphasizing the inevitable exhaustion of reserves or stressing, on the contrary, that new discoveries have regularly led to an upward revision of the estimate of these reserves.

There exists an argument that an oil price shock is likely to have greater impact on real output. Such shock can also reflect both the unanticipated component and the time-varying conditional variance component. The volatility component exerts a significant impact on output growth (Lee et al., 1995). In other words, it is possible that oil price shocks can cause uncertainty in the price of oil, and that oil price volatility can harm output.

From theoretical point of view, an increase in oil price should adversely affect output while a decrease in oil price should induce an expansion of output. An oil price shock can be defined as a rise or a fall in the price of oil that can affect macroeconomic variables (see Hamilton, 1983; Mork, 1989 and Hooker, 1996). Most empirical studies on the relationship between oil price shocks and macroeconomic variables seem to support the oil-real activity nexus.

An oil shock might have different impacts on different economies due to different characteristics. Recently, many empirical research works find evidence on the negative relationship between economic activity and the price of oil in industrialized countries. A rise in oil price can cause production cost to increase, and thus lower future output growth. Gokmenoglu et al. (2016) highlighted that the countries depending on oil significantly contributes to the agriculture sector, thus adding value to the GDP. Likewise, the study of Memis et al. (2015) showed that oil prices have an impact on stock markets. Arouri (2011) argued that oil prices significantly affect macroeconomic events such as interest rates, inflation, unemployment, and consumption. Moreover, ´Alvarez et al. (2011) identified that a rise in the oil price affects banking activities in importing countries rather than exporting countries. Consequently, when fluctuations in oil prices occurs, this is critical for many industries. Thus, shifts in prices can affect different economic sectors and business conditions (BCs) in the country (Charles et al., 2009).

Apart from the fluctuations in oil prices, the problem of energy security has always been at the heart of the concerns of economists in countries with scarce and therefore expensive energy endowments, of which Tunisia is one. Security of supply, which is intended to ensure that essential energy requirements are met, can be achieved, on the one hand, through internal resources exploited under economically acceptable conditions, and, on the other hand, by means of diversified and stable accessible external resources. The intensity of these concerns thus depends on the international energy context.

Thus, fluctuations in the international oil market are thus a source of economic problems in Tunisia. They weaken the economy, distort decision-making and hinder growth. Indeed, any change in the price of oil or its quantities offered or requested could be a major source of macroeconomic imbalances [Ncibi Th (2017)].

5. GDP and Stock Market index nexus

In addition to the oil prices, the relationship between economic growth and stock markets has been of great importance, especially for the growth of underdeveloped economies as they do not have adequate resources for capital. Therefore, the contribution of the efficient stock market not only enables the underdeveloped economy to contribute to the capital, but also facilitate the countries by enhancing the productivity through a better allocation of resources and encouraging innovation.

Indeed, for proponents of financial liberalization, financial markets play an important role in determining the allocation of savings. They determine the cost of capital on the one hand and the value of businesses on the other. They form an anonymous body that guides the use of corporate self-financing and the reallocation of household financial assets. By subjecting business leaders to the threat of transfers of ownership control, markets are a mediator in the use of funds available to managers. The effectiveness of this market discipline is reinforced by the incentive of the managers to the market value of the enterprises. Rating agencies, which forge the standard criteria for assessing firms, are expected to contribute to efficient markets by providing the information needed to form collective judgements on profitability. M&A financiers drive a market for ownership control. These are all mechanisms which, in one way or another, pay for the formation of asset prices on the financial markets. The quality of their regulation of capital accumulation is valid only by the ability of these prices to reveal the fundamental determinants of profitability.

The assumption that stock market is a real indicator of the economic performance explains the linkage between stock market and oil price (Ghosh and Kanjilal, 2016). A number of studies indicate that increase in energy price leads to rising production costs which negatively influences the profit margins and finally transmits to the stock prices of oil importing countries (Ciner, 2001; Basher and Sadorsky, 2006; Ghouri, 2006; Hammoudeh and Choi, 2007; Aloui and Jammazi, 2009).

The well-organized stock market mobilizes the savings and activates the investment projects, which lead to economic activities in a country. The key function of stock market is to act as mediator between savers and borrowers. It mobilizes savings from a large pool of small savers and channelizes these funds into fruitful investments. The preferences of the lenders and borrowers are harmonized through stock market operation. The Stock market also supports reallocation of funds among corporations and sectors. It also provides liquidity for domestic expansion and credit growth.

Fama (1981) examined the relationship between real output and stock prices and showed that there was strong relationship between stock prices and gross national product. Humpe and Macmillan (2009) explored positive long-run between stock prices and the industrial production in US.

Sohail N. and Hussain Z. (2009) investigated long-run and short-run relationships between five macroeconomic variables (Consumer price index, Index of industrial production , Real effective exchange rate, money supply (M2) and three months treasury bills rate) and stock prices in Lahore Stock Exchange (LSE) for the period of December 2002 to June 2008. They found, that in the long run, Industrial production index affected stock returns positively. The increase in Industrial production can play significant positive role in development of the capital markets of Pakistan. Thus, it was recommended that authorities should formulate such a policy which supports stock prices through the promotion of industrial production.

6. International environment –GDP nexus

Tunisia is a small country, with a changing economy based on changes in tourism receipts, agricultural production and manufacturing production. In other words, growth in Tunisia is highly dependent on global conditions, political and climate hazards. However, Tunisia, already weakened by debt and the impact of COVID-19, is trying to "manage" the butterfly effect of the crisis in Eastern Europe, which has a significant impact on its economy.

Russia is the world's second-largest exporter of crude oil. Russia's ongoing military intervention in Ukraine has fuelled fears about the supply of hydrocarbons, particularly from Russia, which has led to a spike in black gold prices.

Oil prices rose again after the OPEC+ exporting countries, led by Saudi Arabia and Russia, decided not to increase production further, thus increasing inflationary pressure in several countries. The Tunisian economy has been heavily affected by the effects of this crisis, which has led to a sharp decline in growth and a rapid rise in unemployment. This crisis has reinforced the fragility of an economy that has been hit for several years by the evils of corruption, inequality and growing unemployment, especially among graduates.

Concretely, the conflict will have an impact on European growth and inflation and therefore on exports to this region. As Europe is Tunisia's largest customer, the rest is easy to imagine: it is one of the vulnerable countries. The IACE estimates, based on the comparative slowdowns, that this could lead to a slowdown in growth in Tunisia, at 2.2% at best, or even 1.5% in a pessimistic scenario. Indeed, and still according to the same note, Tunisia has low storage capacity in addition to the budgetary difficulties it is going through, not to mention that the country is facing a wave of drought that has lasted for three years and that affects its agricultural production.

These considerations lead us to conclude that better governance is necessary for the Tunisian economy to claim resistance to the various shocks coming from an extremely vulnerable international environment.

3. Model estimation and Methodology

3. 1. Presentation of variables

1. **Industrial production (IPI)** refers to the output of industrial establishments and covers sectors such as mining, manufacturing, electricity, gas and steam and air-conditioning. Industrial production index measures changes in industrial production and is widely used for the observation and analysis of the current economic activity. Quaterly survey on industrial production of index allows identifying the turning points in economic development at an early stage.

2. **The Economic Policy Uncertainty (EPU):** This index was developed in 2016 by Bloom N. , Scott Baker R. and Steven J. Davis. It is an original tool for measuring the level of uncertainty related to the conduct of economic policy through the press, tax provisions and economists' forecast variances. The EPU index allows an original first approach to estimate levels of uncertainty and a comparison between countries and major economic and geopolitical events and thus help to read the economic situation. The data used for this variable relate to the United States. Thus, this variable measures the uncertainty that characterizes a bad international environment.

3. **Crude oil volatility index (OVX)** is an index published by Chicago Board Option Exchange since 2007. This index is an estimate of the expected 30-day volatility of crude oil as priced by the United States Oil Fund (USO). In recent years it emerged as an important alternative measure to track and analyze the volatility of future oil prices.

4. **Oil price (OILP) :** Crude Oil Prices: Brent - Europe, Dollars per Barrel. Crude oil price has a close relationship with investors' behaviors. As oil is an important strategic and economic resource, its price is an important indicator to reflect the world economy development. The rise of oil price tends to incur inflation, when oil price rises, investors are likely to invest in alternatives. When investors have inflation expectations, some of them will choose bitcoin to hedge. In addition, the volatility in oil price may affect the development of the world economy, which may influence bitcoin price indirectly.

5. **LCPI:** The Consumer Price Index (CPI) is an instrument for measuring inflation. it makes it possible to follow the average variation in the general level of household consumer prices between two given periods. The CPI synthesises, in a single figure, the variation over time of the cost of a constant basket of goods and services representative of the purchases of a Tunisian household by giving to each product the importance it has in the consumer's budget. The CPI is mainly used to measure the general inflation rate, for the development of monetary policy and for analysis of economic conditions.

6. **TMM:** The money market rate, known as TMM in Tunisia, represents the rate of interbank transactions that derive the various exchanges of liquidity between banks. It is a monthly weighted average money market rate. As a result, the TMM is calculated on the basis of overnight interbank rates.
The money market rate, or the TMM, serves primarily as a reference for the determination of a vast majority of the lending and creditor rates that banks apply to the various economic agents in respect of the loans they receive or the deposits they collect.

7. Stockmarket index : The Tunindex is a benchmark stock market index of the Tunis Stock Exchange, composed of the country's fifty main market capitalizations.

Note that all these variables are expressed in natural logarithm. Moreover, in order to examine whether these series follow a stationary process, various tests are designed. In this context, we chose the Dickey-Fuller test (ADF) the application of which requires the use of a number of delays (p) to be introduced in each variable. In our procedure, we used the model that minimizes the information criteria (Schwartz Information Criterion (SC), Akaike Information Criterion (AIC)).

Table 2: The number of retained delays for each variable

Variables	**LEPU**	**LIPC**	**LIPI**	**LOP**	**LOVX**	**LSTOCKINDEX**	**LTMM**
Number of lags	1	1	4	2	1	2	4

To verify the stationary variables, we refer to the ADF test, which helps to estimate the following models:

$$Model\ (1):\ \Delta X_t = \phi X_{t-1} + \lambda + \delta_t + \sum_{j=1}^{p} y_j\, \Delta X_{t-j} + \varepsilon_t \qquad (1)$$

$$Model\ (2):\ \Delta X_t = \phi X_{t-1} + \mu + \sum_{j=1}^{p} y_j\, \Delta X_{t-j} + \varepsilon_t \qquad (2)$$

$$Model\ (3):\ \Delta X_t = \phi X_{t-1} + \sum_{j=1}^{p} y_j\, \Delta X_{t-j} + \varepsilon_t \qquad (3)$$

On the other hand, the stationarity test consists in rejecting the null hypothesis (according to which X_t is non-stationary but contains at least one unit root) if the ADF statistical test is lower than the critical value tabulated by Dickey Fuller. In this case, the X_t series is stationary (i. e. it is integrated of order zero). The following table shows the ADF test level:

Table 3 : The ADF test in level

	LEPU	**LIPC**	**LIPI**	**LOP**	**LOVX**	**LSTOCK INDEX**	**LTMM**
(1)	-5.544699	-6.951057	-1.903864	-1.843956	-5.386490	-1.531187	-0.878665
***	-3.588509	-3.588509	-3.592462	-3.588509	-3.588509	-3.596616	-3.588509
**	-2.929734	-2.929734	-2.931404	-2.929734	-2.929734	-2.933158	-2.929734
*	-2.603064	-2.603064	-2.603944	-2.603064	-2.603064	-2.604867	-2.603064
(2)			-6.563287	-2.770838		-2.504009	-1.438956
***			-4.180911	-4.180911		-4.205004	-4.180911
**			-3.515523	-3.515523		-3.526609	-3.515523
*			-3.188259	-3.188259		-3.194611	-3.188259
(3)				-0.628512		-1.142829	-1.045349
***				-2.618579		-2.621185	-2.618579
**				-1.948495		-1.948886	-1.948495
*				-1.612135		-1.611932	-1.612135
In level	Stationary	Stationary	Stationary	No stationary	Stationary	No stationary	No stationary

Note:

***, ** and * show the significance at 1%, 5% and 10% levels, respectively

(1) with a trend and a constant (2) without a trend and with a constant (3) without a trend and a constant

By applying the Dickey-Fuller test, we notice that the variables are non-stationary. Therefore, they must be stationarized.

The studied stationary variables for the Tunisian case are summarized in the following table.

Table 4: The stationnarization response variables

	ADF value	Critical Value	ADF test result
LEPU	-5.544699 (1)	-3.588509 (***)	Integrated of order 0
LIPC	-6.951057 (1)	-3.588509 (***)	Integrated of order 0
LIPI	-6.563287 (2)	-4.180911 (***)	Integrated of order 0
DLOP	-8.112076 (3)	-2.619851 (***)	Integrated of order 1
LOVX	-5.386490 (1)	-3.588509 (***)	Integrated of order 0
DSTOCKINDEX	-5.079497 (3)	-2.624057 (***)	Integrated of order 1
DLTMM	-4.658428 (3)	-2.619851 (***)	Integrated of order 1

Note:

***, ** and * show the significance at 1%, 5% and 10% levels, respectively

(1) with trend and with constant , (2) without trend and with constant , (3) without trend and without constant

On applying the Dickey-Fuller test, it can be noticed that the variables “LEPU” ,“LIPI“, “LIPC“ and “LOVX“ are stationary in level. On the other hand, the variables “LOP“ “LSTOCKINDEX“ and “LTMM“ are stationary in first difference.

The implementation of Philips-Perron test is then identical to the ADF test. Besides, the critical values and the decision rule are the same as those in the ADF test. The results of the application of the Philips-Perron test are presented in the following table:

Table 5: The Philips-Perron test

	T-stat	Critical Value
LEPU	-5.577599(1)	-3.588509 (***)
LIPC	-6.944904(1)	-3.588509 (***)

LIPI	-6.577693(2)	-4.180911(***)
ΔLOP	-8.141658(3)	-2.619851(***)
LOVX	-5.419302(1)	-3.588509 (***)
ΔSTOCKINDEX	-4.905187(3)	-2.624057(***)
ΔLTMM	-4.783465(3)	-2.619851(***)

After having demonstrated the presence of a unit root in the studied series, it is possible to test whether these variables are co-integrated. This consists in studying the interdependencies between these variables and testing the existence of a long-term stable relationship, which is called “co-integration” or “long-term relationship”.

To test the number of relationships of co-integration, we referred to the work of Johanson S. and Jeseluis K. (1992), who suggested two types of tests: the trace test and the maximum eigenvalue test. Before the implementation of these tests, it is fundamental to test the presence or absence of a deterministic component and / or a constant in the co-integration vector.

Table 6 : The Cointegration test

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.932317	244.9641	125.6154	0.0000
At most 1 *	0.812426	142.6332	95.75366	0.0000
At most 2 *	0.582966	79.03713	69.81889	0.0077
At most 3	0.489557	45.80278	47.85613	0.0770
At most 4	0.267247	20.24864	29.79707	0.4061
At most 5	0.198806	8.432651	15.49471	0.4204
At most 6	0.000260	0.009868	3.841466	0.9206

Trace test indicates 3 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.932317	102.3309	46.23142	0.0000
At most 1 *	0.812426	63.59607	40.07757	0.0000
At most 2	0.582966	33.23435	33.87687	0.0595
At most 3	0.489557	25.55414	27.58434	0.0889
At most 4	0.267247	11.81599	21.13162	0.5659
At most 5	0.198806	8.422783	14.26460	0.3374

At most 6	0.000260	0.009868	3.841466	0.9206

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

According to the trace test, there are three relationships of co-integration between the variables. On the other hand, according to the test of the maximal eigenvalue, there are two relationships of co-integration between the considered variables. Consequently, there are long-term relationships between the variables in Tunisia.

Because of the existence of a relationship of co-integration, the VAR has been considered as a form of error correction (VECM). This last model represents a VAR with estimated co-integration. In fact, the VAR model is an econometric tool applied to measure all the dynamic connections inside a group of given variables. It enables, on the one hand, to analyze the effects of a variable on another through random shock simulations and, on the other hand, to conduct an analysis in terms of causality

The VAR model with "k" variables and "p" time lag, denoted VAR (p) is written as:

$$Y_t = A_0 + A_1 . Y_{t-1} + A_2 . Y_{t-2} + \ldots + A_p . Y_{t-p} + \gamma_t \Leftrightarrow A(D) . Y_t = A_0 + \gamma t,,$$

where Y_t is a vector of dimension (k ; 1) and γ_t is the residue vector.

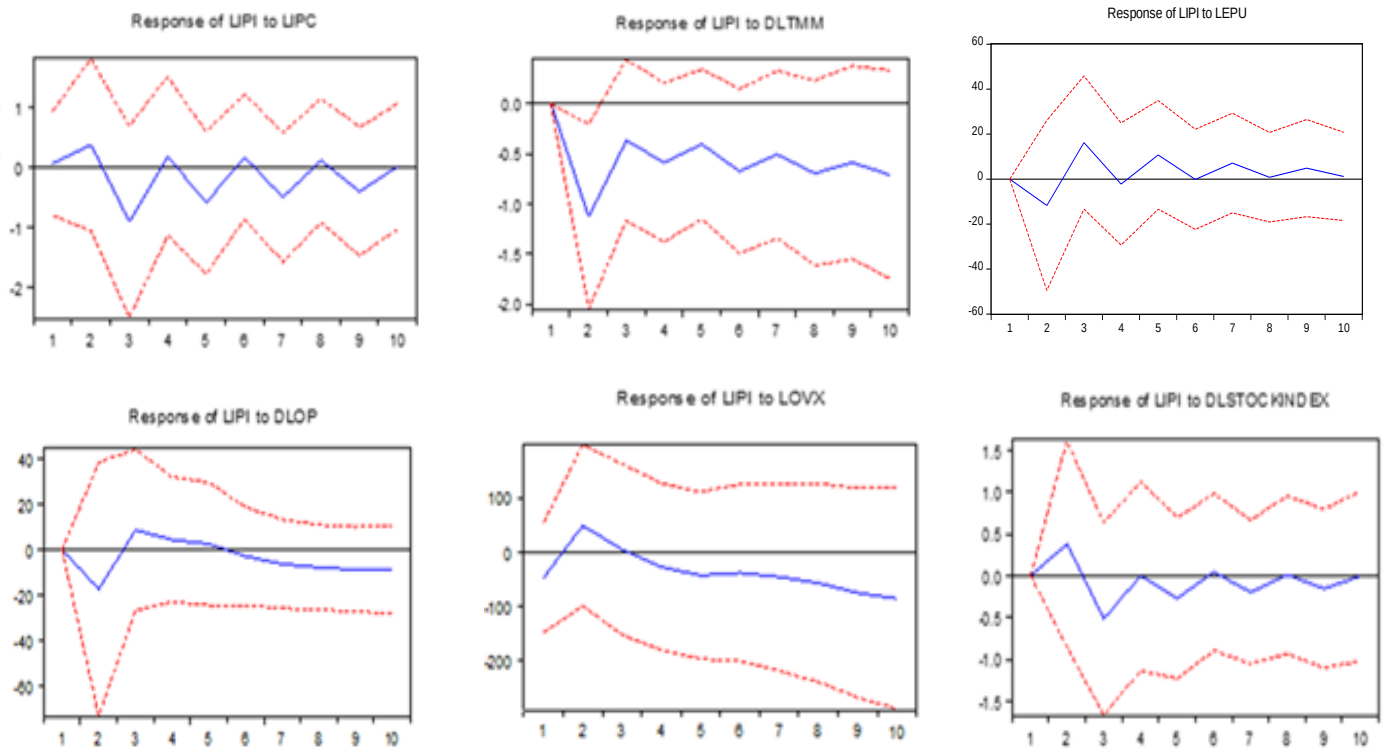
The used VAR model is written in the form of $Y_t = A_0 + A_1 . Y_{t-1} + \gamma_t$, which gives:

$$\begin{pmatrix} \mathrm{LEPU}_t \\ \mathrm{LIPC}_t \\ \mathrm{LIPI}_t \\ \Delta\mathrm{LOP}_t \\ \mathrm{LOVX}_t \\ \Delta\mathrm{STOCKINDEX}_t \\ \Delta\mathrm{LTMM}_t \end{pmatrix} = A0 + \begin{pmatrix} A_1^1 A_1^2 A_1^3 A_1^4 A_1^5 A_1^6 A_1^7 \\ A_2^1 A_2^2 A_2^3 A_2^4 A_2^5 A_2^6 A_2^7 \\ A_3^1 A_3^2 A_3^3 A_3^4 A_3^5 A_3^6 A_3^7 \\ A_4^1 A_4^2 A_4^3 A_4^4 A_4^5 A_4^6 A_4^7 \\ A_5^1 A_5^2 A_5^3 A_5^4 A_5^5 A_5^6 A_5^7 \\ A_6^1 A_6^2 A_6^3 A_6^4 A_6^5 A_6^6 A_6^7 \\ A_7^1 A_7^2 A_7^3 A_7^4 A_7^5 A_7^6 A_7^7 \end{pmatrix} \times \begin{pmatrix} \mathrm{LEPU}_{t-1} \\ \mathrm{LIPC}_{t-1} \\ \mathrm{LIPI}_{t-1} \\ \Delta\mathrm{LOP}_{t-1} \\ \mathrm{LOVX}_{t-1} \\ \Delta\mathrm{STOCKINDEX}_{t-1} \\ \Delta\mathrm{LTMM}_{t-1} \end{pmatrix} + \gamma t$$

Using this model, we will analyze the effects of the Tunisian educational policy by resorting to the analysis of the impulse response functions as tools to measure the impact of a shock on the variables. Then, we will focus on the effects of shocks over 10 periods each of which is four and half years long.

Figure 3: Functions of impulse responses of LIPI

Response to Cholesky**'s** One S.D. Innovations 2 S.E.

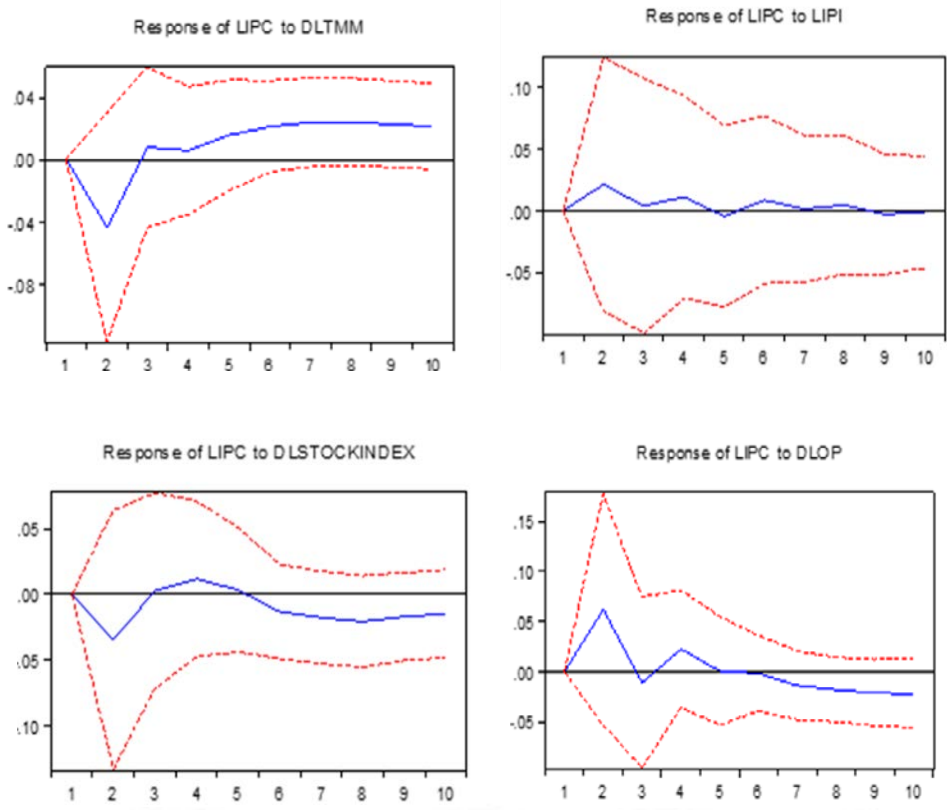


4. Interprétations :

The incidence of the shock LIPC on LIPI:
A shock on inflation has a slight positive impact on IPI of 2,10 %. This shock is persistent and results in fluctuations in industrial production. However, this effect disappears after the tenth period. The fluctuations observed are cushioned by the equilibrium price expectations. When the price is high, producers expect a lower equilibrium price and vice versa.

The incidence of the shock interest rate on LIPI:
A shock on inflation has a negative impact on IPI of 6,29 %. The increase in the key interest rate has as a consequence a slowdown in economic growth and a worsening of inflation in view of the weak development of the industrial production index.
The increase in the key interest rate will result in a slowdown in economic growth and a worsening of inflation in view of the weak development of the industrial production index, which has recorded a continuous decline.

Figure 4: Functions of impulse responses of LIPC



The graphs show the behaviour of inflation at different shocks. A positive shock (rise) of the TMM leads to a fall in inflation in the very short term (at the end of the first period). However, this effect disappears quickly and inflation increases in the long term. Similarly, an oil price shock leads to a rise in inflation in the very short term that disappears in the medium and long term. In the very long term, inflation decreases.

A positive shock affecting the stock index leads to a fall in inflation in the short term. This effect disappears in the medium term, and then decreases in the long term. If publicly traded companies are performing, it is because they manage to control their costs and their profits increase. This favours them in increasing their dividends, and it also has a positive effect on their market valuation. As a result, this recovery in equity markets has a positive effect on inflation. High-performing companies will pass on lower production costs to their tariffs, which slows down inflation.

The CBT's ideology is that inflation is everywhere and always of monetary origin, that is to say that it can only come from a too large distribution of credits. To combat this monetary inflation, interest rates would have to be raised to reduce inflation. The reality in Tunisia is quite different. Inflation in Tunisia increased mainly with the liberalization of the dinar in April 2016 and then accelerated especially after the March 2017 dinar stall.

These figures thus support our interpretation that inflation is mainly due to the liberalization of the dinar and then to the fall in its value which increases the prices of imported goods. As proof, the increase in the key interest rate of the CBT in April and May 2017 had no impact on inflation. In fact, inflation has never been as high as it has been since the IMF forced the BCT to focus only on fighting inflation.

The failure of the monetary policy promoted by the IMF is therefore total. Not only is inflation not monetary, but it comes directly from the policies imposed by the IMF [liberalization of the

dinar, increase in value-added tax (VAT) and gasoline prices]. Moreover, in its second review, the IMF acknowledges that the increase in interest rates has no impact on credit demand. Meanwhile, inflation and rising interest rates are financially stifling households and businesses in Tunisia. It is becoming urgent to redefine the mission of the CBT by adapting it to the needs of the Tunisian economy (unemployment, growth, investment).

The incidence of the shock Stockmarket index on LIPI:

A shock on Stockmarket index has a slight positive impact on IPI of 3,4 %. However, this effect disappears quickly. The stock market has a lower impact on growth in the Tunisia. Indeed, Tunisian households have a lesser stock market wealth (especially for their retirement). In addition, Tunisian companies finance themselves less via the stock market and prefer bank financing.

The incidence of the shock Cruel oil price on LIPI:

At the macroeconomic level, a shock on cruel oil price has a negative impact on IPI of 3,3 %. An increase in the general price index and consequently, a negative impact on the growth. This result is interpreted as follows: Soaring oil prices are adding to Tunisia's energy bill. In reality, the evolution of the price of oil affects the formation of the prices of several goods and services and leads to a general increase in prices. As a result, rising oil and derivatives prices weigh heavily on the consumer's purchasing power.

One of the cruel ironies that exists today is the link between rising energy prices and rising food prices. This combination can have devastating effects on global poverty and food security. High energy prices have increased fertilizer and transportation costs.

The immediate challenge for the authorities is to control the negative macroeconomic impact of rising oil prices and to cope with inflation. In this regard, Tunisia may build up oil security stocks that they can make available to reduce the impact of a temporary shortage or a significant price increase. A longer-term solution is to adopt renewable energy.

The incidence of the shock OVX on LIPI:

A shock on OVX has a slight positive impact on IPI of 7,8 %. This effect disappears quickly et devient négatif. Due to current high and volatile prices, Tunisia, like all oil-importing countries, has difficulty budgeting its energy expenditures. Volatility has also hurt its economic growth, investment and trade. As a result, it has lost ground in their fight against poverty. In this regard, Bacon R. & Kojima M. (2006) argue that oil price volatility has put pressure on developing countries looking for ways to mitigate market fluctuations.

In this regard, Tunisia has used a price-levelling strategy in which the country sets a target price for oil. Under this policy, the government subsidizes oil if the international price is higher than its target price and collects taxes on oil when its international price is lower than its target price. However, this policy often has the effect of encouraging greater consumption of gasoline and subsidizing the rich.

Another technique is "hedging", which is the use of derivative financial instruments such as futures, options and collars, which, at a cost, can mitigate the risk of price fluctuations. These financial derivatives are the best way to transfer oil price risks to markets, provided they are used in a sound governance and trading platform. Financial derivatives are highly effective in mitigating oil price risks in the short and medium term (5-7 year horizon). In the long term, however, other solutions (such as oil funds) can be used."

Bacon R. & Kojima M. (2006) explain that coverage, a strategy rarely used by governments but frequently used by corporations, requires a very high level of expertise and can have the opposite effect if an adequate internal control and governance structure is not in place..

The incidence of the shock EPU on LIPI:

A shock on EPU has a negative impact on IPI of 1,54 % and it's still negative. Several recent papers have provided evidence that increase in the economic policy uncertainty in great nations has played a significant role in the slow-down and the increase in unemployment in several emerging economies. For example, Kouparitsas (2001) studies the transmission of fluctuations between countries from the north to the south. The study finds that the international business cycle extends southward by showing that there is a strong positive correlation between the growth rates of northern and southern GDP. Other works has focused on the different mechanisms by which fluctuations can be transmitted from one country to another. International transmissions of economic activity are particularly dependent on trade [Frankel and Rose (1998); Baxter and Kouparitsas (2005)]. Other transmission channels can be considered, linked to monetary or financial variables (financial integration, similarity of monetary and fiscal policies...). The analysis of the nature of shocks and their transmission channels has been the subject of an important literature applied to different countries.

The figure showing the impact of a shock on policy implementation uncertainties in major nations shows that economic performance in Tunisia remains today surrounded by large downside risks linked to future economic policy and state-tradingUnited in the Brexit negotiations, the vulnerability of the financial system in some countries (China in particular) and the different geopolitical tensions. However, as soon as the first signs of this crisis appear, the public authorities react to take the necessary measures to limit its effects and contain its possible repercussions. Overall, these provisions have a double scope:

- A cyclical scope aimed at supporting companies that could experience a decline in their activities;
- And a structural scope aimed at developing competitiveness and boosting economic activity.

In addition, the Tunisian economy often attracts foreign investors who want to establish themselves in Tunisia and benefit from the various assets at their disposal. The opening of the capital account of Tunisian companies resulting from foreign direct investment operations will not fail to strengthen their competitiveness and stabilize the national economy.

5. Conclusion :

The Tunisian economy is suffering from the economic consequences of the international economic situation (such as the war in Ukraine), which was a major exogenous shock in addition to the COVID-19 pandemic. Pressures increase the underlying structural weaknesses of the economy. The short-term outlook is expected to be challenging as growth is likely to contract while higher international energy prices will add to already high inflation and increase fiscal and external deficits, and the debt. Urgent measures are needed to reduce these imbalances in a socially sustainable way.

One of the main objectives of the Central Bank in Tunisia (CBT) is to support growth while controlling inflation, which is becoming a major concern. In order to cope with this inflationary trend, the CBT used the main tool to raise the key interest rate, at the risk of influencing investment by the increase in loans. However, the source of inflation in Tunisia today is not

really monetary. An examination of the liquidity ratio of the economy, as measured by the M3/GDP ratio, shows that the money supply has been established at levels compatible with the development of activity, which supports the absence of monetary inflationary pressures.

However, it seems that this inflation is more a result of a mismatch between supply and demand of goods and services and the policy of depreciation of the dinar, than of monetary origin. Indeed, disruptions in distribution channels, the depreciation of the dinar against the euro and the dollar, plus the delayed effect of the exceptional rise in wages, seem to have an impact on inflation rates.

Rising real interest rates to exceptionally high levels, their sustainability at values between 5 and 10% since the revolution is the major characteristic of the recent period and is one of the keys to interpreting economic developments since 2011. The increase in the key interest rate of the Central Bank of Tunisia (CBT) resulted in a slowdown in economic growth and a worsening of inflation in view of the weak development of the industrial production index.

Through the increase in the money market interest rate, we have achieved a slowdown in growth through the decline in household consumption and the stagnation of investment. It should be pointed out that the growth achieved in recent years has mainly come from consumption and not from investment, as a result of the consequent increases in wages.

In order to promote growth while controlling inflation, we believe it is in the interest of the CBT to distinguish between development and investment banking activities and consumer banking activities; to promote investment loans by reducing the cost of financing; to review the specific loans that Tunisian banks offer on the market and their impact on the money supply in circulation; and to control energy consumption.

Moreover, Tunisia will gradually have to make its growth model less dependent on short-term fluctuations, which will require its productive structure to be made more complex by the relations maintained by the various sectors on cross-cutting activities where level will play a central role.

It is the progressive development of these transversal activities in particular based on creative services and industries where research, brands, cultural industries, ICTs play a central role in enabling growth to take place online in the long term (including in traditional sectors such as textiles, clothing and leather and the rural world). And here the choices of openness and incentives to foreign investment as well as international cooperation must be able to play a decisive role.

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