Modelling Inflation Shifts and Persistence in Tunisia: Perspective from an Evolutionary spectral approach

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Abstract

The main objective of this paper consists to study what we learned about the dynamic of Tunisian inflation rate in the last two decades. This question is overriding concern to monetary policy analysis because it gives us information’s on inflation forecasting. In other words, before given monetary policy recommendations to Tunisian policy makers, after the actual downward of economic indicators and the disarmed of monetary policy consequently of Arabic spring, it is consistent to learn and to know the main characteristics of inflation history in this country. In this work, we suggest studying the specifics of Tunisian inflation dynamic’s on two dimensions. Firstly, we think that is useful to learn the different Tunisian inflation experiences regimes. Then, we try to analysis the nature of Tunisian inflation rate response to shocks; we try to analysis the inflation persistence in order to determine the nature of economy response’s to different chocks. This is the first paper proposing this methodology to analyse monetary policy and there is the first one proposing a measure of inflation persistence. In this work, we contribute to empirical literature of inflation persistence by it proposing a new measure based on the theory of evolutionary co-spectral analysis proposed by Priestley and Tong (1973). The mains findings of this paper show a stable inflation regime around 5.5% in the last ten years. We prove that the Tunisia inflation had a higher degree of inertia which traduce it’s gradually response on shocks. Consequently, we suggest to policy makers to make institutional reforms to reduce inflation.

Key-words: Inflation, Structutural Break, Spectral Analysis, auto-spectral analysis, Bai Berron test, inflation persistence.

JEL Classification: C16, E52, E63.

I- Introduction

After the Arabic spring many economic indicators has been downward in concerning countries. Especially in the case of Tunisia, many monetary indicators have been dis- torted such as growth rate, inflation and inflation uncertainly. Indeed, since 14 January 2011 the prices of
necessary goods (foods, energy...) raise and have a higher volatility. This higher volatility of inflation has a bad effect on economy. Its discourage investment, consumption, industrial competition, economic growth...For these reasons, policy makers of Tunisian Central Bank, Tunisian economic ministry and some researchers of African development banks think about the reforms and action that must be followed to remove from this difficult economic situation. Primarily, these researches talk about the level of interest rate that bank must undertake and about the level of liquidity that Central bank must injected in bank sector. However, the decision about monetary policy is based on forecasting. More attention must be given in inflation forecasting. The attached central bank to forecast inflation lead to best understands of the dynamic of the inflation.

Modern monetary economic theories as, for example, Svenson (1997, 1999), Clarida et al. (1999), Stock and Watson (2002)...show that the inflation is being determined by output gap, interest rate with a dynamic system that involves an Euler equation, a short Phillips curve and a central bank loss function. In this system, understanding the dynamic of inflation consists on determining, on one hand, the different experiences regime of inflation rate and in another hand, the nature of the inflation persistence. Indeed, according this system, the persistence of inflation has been a regular area of study since such inertia appears to be stylized facts observed in empirical studies.

According the modern economic theories, knowing the inflation regimes experiences, inflation persistence are all relevant elements to make a best inflation forecasting and best monetary policies actions. So, our main idea in this paper suggests that it is primordial, before thinking on actions that must be undertaken to escape monetary indicators or on thinking about monetary policy alternative, to study the characteristic of the inflation dynamic. Learning inflation specifics and knowing the experience of inflation regime experience allow us to take the best decisions and the relevant action for the future.

The economic literature proposed many ways to analyses the monetary policies. Most of them analysis the monetary policy, according a VAR approach and impulse responses functions such as Huh (1996), Bernanke and al. (1999), Bernanke and Mihov (1998), Lane and Van Den Heuvel (1998), Da Silva and Portugal (2000), Honda (2000). Few researches analyse the dynamic of inflation by determining only the regimes of inflation rate such as Pétursson (2004), Levin, Natalucci and Piger (2004), kontonikas (2004), Genc et al. (2007), Ftiti and Essaadi (2008). In the case of Tunisia, in our acknowledge- ment, there are no researches interesting on analysing inflation rate characteristics which are useful to inflation forecasting. Most of researches focus on monetary policy analysis according a VAR approach and impulse responses functions such as Boughrara (2003), Smida and Boughrara (2004), Ben Naceur et al. (2007).

The main objective of this paper consists to study what we learned about the dynamic of Tunisian inflation rate in the last two decades. This question is overriding concern to monetary policy analysis because it is giving us information’s on inflation forecasting. In other words, before given monetary policy recommendations to Tunisian policy makers, it is consistent to

---

1 In August 2012 the fuel price, in September 2012 the electricity price rise too.
learn and to know the main characteristics of inflation history in this country. In this work, we suggest studying the specifics of Tunisian inflation dynamics on two dimensions. Firstly, we think that it is useful to learn the different Tunisian inflation experiences regimes. Then, we try to analysis the nature of Tunisian inflation rate response to shocks. In other words, we try to analysis the persistence of inflation: there is a gradual response to shocks or no? Studying the inflation persistence is useful for policy recommendations if disinflationary environment must be undertaken. 

This paper, contrary to previous studies, is the first one analysing the dynamic of inflation on two points: inflation experiences regimes and inflation persistence. In addition, to this contribution, our analysis contains other empirical contributions. Firstly, we propose a new techniques-evolutionary spectral analysis, Priestley 1965- of inflation representation having many advantaged cited below. Then, we propose a new time-varying measure of the reduced form of the inflation persistence which is an extension that we proposed to evolutionary co-spectral analysis based on Priestley and Tong (1973). The evolutionary spectral analysis is a time frequencies approach, contrary to time series model, it allows for a representation of non-stationary series without any risk of misspecification. It didn’t depending on any previous modelling. Then, the evolutionary spectral analysis hasn’t an “end-point problem”: no future information is used, implied or required as in band-pass or trend projection methods. The most important contribution regarding traditional time series analysis consists on the decomposition of series on two dimensions: a frequency dimension and temporary one. The contribution of the frequency component has a role to decompose time series according different horizon, for example a short-run horizon, medium-term horizon and long-run horizon. So, in this work, we benefits for all these positives points and we need in our analysis to decompose inflation series and inflation persistence in the two horizons in order to know the action of monetary policy in the short-run and in the medium-run.  

This paper is organized as follows. Section 2 presents Empirical methodology to determine different regime of Tunisian inflation rate and the measure of inflation persistence. Section 3 presents the data. Section 4 is concerned to results and discussion.

II- Methodology

In this section, we present our empirical methodologies. Behind that we have twofold objectives-identification of Tunisian inflation regimes and determination of inflation persistence: We follow two empirical methodologies based on frequency analysis: the first one concerns univariate process and the second one is concerned to bivariate process.

Firstly, in order to determine the Tunisian inflation regimes, our methodology consist to model the inflation rate according a time-frequency approach of Priestley (1966-1996) to distinguish

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2 In traditional time series methods consist a primary step of series modelling according ARMA, GARCH models and then studied the modelled process. In these techniques, we have a great risk of misspecification when, for example, a series has a break point and we have not tacked it into account in the modelling process.

3 We didn’t focus on the long run because the objective of Tunisian monetary policy is to ensure price stability in the medium-term.
between short-run inflation from the medium-run one. Then, the break points are identified on studied frequencies (we select 3 frequencies, two frequencies presenting the short-run inflation—respectively 4 months and 1 year—and one frequency which traduce a medium-term inflation—3 years) according the Bai perron test (2003). This test has many advantage compared to the traditional one. It allow to detect multiple break points and endogenously.

Secondly, in this paper we propose a new measure of inflation persistence that is presented in the first time in this paper. We present a time-varying measure of inflation persistence in a frequency domain. The measure that we present is an extension to the theory of co-evolutionary spectral analysis of Priestley and Tong (1973). The advantage of our measure consists is validity for non-stationary series, we didn’t lose any information on the decomposition of time series. We present a measure of inflation persistence calculated on many frequencies in order to distinguish short-term persistent from the medium-run.

1. Identification of Tunisian inflation regimes: Evolutionary spectral analysis

In this section, we presented the followed methodology to determine the different regime of Tunisian inflation rate. We start with the definition of the evolutionary spectrum proposed by Priestley (1965) used in this work to model the Tunisian inflation rate. Then, we present the estimation method of the evolutionary density function of inflation (Priestley, 1965-1988). At the end, we present the Bai Perron test (2003) that we apply to the inflation spectral density function in order to determine the experiences regime of inflation in Tunisia.

**Definition**

The evolutionary spectrum theory (Priestley, 1965) defined any process according the following equation (eq.1). Indeed, the Tunisian inflation rate is defined as follows:

$$inf_t = \int_{-\pi}^{\pi} A_{inf}(w, t) e^{iwt} dZ_{inf}(w)$$

(1)

Where, for each $w$, the sequence $A_{inf}(w, t)$ is a time dependent for non stationary process. If the process is stationary the above sequence is only frequency dependent and equal to $A_{inf}$. The sequence $A_{inf}(w, t)$ has a generalized Fourier transform whose modulus has an absolute maximum at the origin. $\{dZ_{inf}(w)\}$ is an orthogonal process on $[-\pi, \pi]$ with $E\{dZ_{inf}(w)\} = 0$. Without loss of generality, the evolutionary spectral density of the process $inf_t$ is defined by $h_t(w)$ as follows:

$$h_t(w) = \frac{dH_t(w)}{dw}$$

(2)

---

4 This approach has many advantage compared by other used in literature. First of all, the main specificity of this methodology consists on studying inflation on two dimensions; the frequency dimension and the temporary one. The frequency dimension allows distinguishing between short-run inflation component form the long-run component. Secondly, representing the inflation rate according the evolutionary spectral theory is useful for non-stationary series. So, we do not need any prior treatment of stationary for the data. Thirdly, it allows us not to lose any information related to the inflation series that require already some processing of smoothing.

5 For more details, see Priestley (1965, 1996)
Where, \( dH_t(w) = |A_{inf}(w,t)|^2 \mu_{inf}(w) \). The variance \( \sigma_{inf,t}^2 \) of \( inf_t \) at time \( t \) depends on the evolutionary spectral density \( h_t(w) \) through the following equation.

\[
\sigma_{inf,t}^2 = \text{Var}(inf_t) = \int_{-\pi}^{\pi} h_t(w) \, d(w)
\]  

(3)

**Evolutionary spectral density function estimation of the Tunisian inflation rate**

According to Priestley (1965), the estimation of the evolutionary spectrum is performed by using two windows \( \{g_u\} \) and \( \{W_v\} \). Without loss of generality, \( h_t(w) \) is constructed as follows:

\[
\hat{h}_t(w) = \sum_{v \in Z} w_v \left| u_{t-v}(w) \right|^2
\]  

(4)

Where, \( \{g(u)\} \) and \( \{w_v\} \) are defined as follows:

\[
g(u) = \begin{cases} 
\frac{1}{2\sqrt{h\pi}} & \text{if } |u| \leq h \\
0 & \text{if } |u| > h
\end{cases}
\]

\[
W_v = \begin{cases} 
\frac{1}{T'} & \text{if } |v| \leq \frac{T'}{2} \\
0 & \text{if } |v| > \frac{T'}{2}
\end{cases}
\]

In this paper, we take \( h = 7 \) and \( T' = 7 \). We opt for this choice, as do Priestley (1995), Artis, Bladen-Hovell and Nachane (1992) and Ahamada & Boutahar (2002). According to Priestley (1988), we have \( E(\hat{h}_t(w)) \approx h_t(w) \), \( \text{var}(\hat{h}_t(w)) \), decreases when \( T' \) increases. \( \forall (t_1, t_2) \), \( \forall (w_1, w_2) \) if at least one of the following conditions \( (i) \) and \( (ii) \) is satisfied.

\[
(i) \ |t_1 - t_2| \geq T' \quad (ii) \ |w_1 \pm w_2| \geq \frac{\pi}{h}
\]

**Structural break test: Bai and Perron test (2003)**

In our analysis, we define the break point as a change in the inflation dynamic which occurred as response of exogenous shocks or change in monetary policy. Empirical literature proposes large techniques to detect multiple break points. Many tests exist such as the seminal work of Chow (1960), the CUSUM test of Brown et al. (1994) focusing on testing structural change at a single specified known break date. Recently, there was a development of methods to estimate and to test of structural change at unknown break dates. These include the test proposed by Andrews et al. (1996) that considers multiple structural changes but requires a well-known variance. Also, the one of Liu and al. (1997), which tests for multiple unknown change points but considers only the pure structural change case where all parameters are subject to shifts. Bai and Perron (1998) propose another test focusing on the instability problem over time. It allows the estimation of multiple structural shifts in a linear model estimated by least squares. More precisely, the Bai-Perron test (1998) is based upon an information criterion in the context of a sequential
procedure, and allows finding the number of breaks implied by the data, as well as estimating the
timing of the breaks and the parameters of the processes between the breaks.

In this paper, we suggest that the Bai Perron test is the suitable test for our purposes. We study
the dynamic of inflation series on some frequencies. For each studied frequency, we try to
determine their mean-shifts. Bai Perron test allows us to identify endogenously multiple break
points in each series. We use GAUSS software and we obtain the estimate by running the code
created by Bai and Perron (1998, 2003b).\(^6\)

The standard linear regression model as following:

\[ y_t = x'_t \beta_j + u_t \quad for \ t = T_j-1 + 1, \ldots, T_j \quad and \ j = 1, \ldots, m + 1. \quad (8) \]

With \( y_t \) is the observation of the dependent variable, \( x_t \) is a \( k \times 1 \) vector of regressors, \( \beta_j \) is
\( k \times 1 \) the vector of regression coefficients and \( u_t \) is the error term. The parameter \( m \) is the
number of breaks.

Note that in this structural change model, all the coefficients are subject to change over
time. The hypothesis that the regression coefficients remain constant is:

\[ H_0: \beta_i = \beta_0 \quad for \ i = 1, \ldots, n. \]

The break points \((T_1, \ldots, T_m)\) are explicitly treated as unknown and for \( i = 1, \ldots, m, \) we have
\( \lambda_i = \frac{T_i}{T} \) with \( 0 < \lambda_1 < \ldots < \lambda_m < 1. \)

The purpose is to estimate the unknown regression coefficients and the break dates
\((\beta_1, \ldots, \beta_{m+1}, T_1, \ldots, T_m)\) When \( T \) Observations on \((x_t, y_t)\) are available.

Bai and Perron (1998) impose some restrictions on the possible values of the break dates.

Indeed, they define the following set for some arbitrary small positive number \( \varepsilon \) as the
following:

\[ \lambda_\varepsilon = \{(\lambda_1, \ldots, \lambda_m); |\lambda_{i+1} - \lambda_i| > \varepsilon, \lambda_1 > \varepsilon, \lambda_m > 1 - \varepsilon\} \]

Bai and Perron (1998-2003b) present some asymptotic critical values for the arbitrary small
positive number \( \varepsilon \) and the maximum number of breaks (M). For example, \( \varepsilon = 0.05 \) \( M = \)
9, \( \varepsilon = 0.10 \) \( M = 8, \) \( \varepsilon = 0.15 \) \( M = 5, \) \( \varepsilon = 0.2 \) \( M = 3, \) \( \varepsilon = 0.25 \) \( M = 2. \) In our work, we follow Bai and
Perron (1998): \( \varepsilon = 0.15 \) \( M = 5 \)

2. Measure of inflation persistence: Auto-spectral density function

Priestley and Tong (1973) propose a Time Varying measure of co-spectral density function
between a bivariate process \( \{x_t, y_t\} \). In this paper, we present an extension of this theory in order

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\(^6\) The code is available on the Perron home page: http://people.bu.edu/perron/.
to propose a new measure of time-varying autocorrelation function in a frequency domain. This new measure is called Evolutionary Auto-Spectral Density Function (EASDF). By reference to co-spectral density function proposed by Priestley and Tong (1973), we substitute in our case \( y_t \) by \( x^d \); with \( d \) is a dealy. \( x^d = X_{t-i} \) for \( i=1, \ldots, q \). \( q \) represents the lags of inflation that we take to compute persistence of inflation.

\[
X_t = \int_{-\pi}^{\pi} A_{tX} \, e^{j\omega t} \, dZ_X(w) \quad \text{and} \quad X^d = \int_{-\pi}^{\pi} A_{X^d} \, e^{j\omega t} \, dZ_{X^d}(w)
\]  

(1)

With \( E[dZ_X(w_1)dZ_X^*(w_2)] = E[dZ_{x^d}(w_1)dZ_{x^d}^*(w_2)] = E[dZ_X(w_1)dZ_{x^d}^*(w_2)] = 0 \)

And for \( w_1 = w_2 \)

\[
E[|dZ_X(w_1)|^2] = d \mu xx(w_1) ; \quad E[|dZ_{x^d}(w_1)|^2] = d \mu x^d x^d(w_1) ;
\]

\[
E[dZ_X(w_1)dZ_{x^d}^*(w_1)] = d \mu x^d x^d(w_1)
\]

By virtue of the Cauchy-Schwarz inequality, we can write that:

\[
|dH_{tXX^d}|^2 \leq dH_{tXX} \, dH_{tX^dX^d} ; \quad \text{for all } t \text{ and } w
\]

\[
dH_{tXX^d} = h_{tXX^d}
\]

Where \( h_{tXX^d} \) may then be termed the evolutionary auto-spectral density function. In time domain, this Time varying function is equivalent, according the Fourier transformation, to the dynamic auto-correlation function. In this paper, \( h_{tXX^d} \) is the Time Varying inflation persistence measure. The estimation of the evolutionary auto-spectral density function needs two filters. For the discrete univariate process, Priestley (1966) gives two relevant windows. These are relevant filters and they are tested by several researchers such as Ahamada and Boutahar (2002), Ftiti (2010) and Bouchouicha and Ftiti (2012). For the discrete bivariate process, Priestley and Tong (1973) adopt the same choice that:

\[
g_u = \begin{cases} 
\frac{1}{2\sqrt{\pi h}} & \text{if } |u| \leq h \\
0 & \text{otherwise}
\end{cases}
\]

\[
w_v = \begin{cases} 
\frac{1}{T'} & \text{if } |v| \leq \frac{T'}{2} \\
0 & \text{if } |v| > \frac{T'}{2}
\end{cases}
\]

Then, the estimation of the evolutionary auto-spectral density function is as follows:

\[
\hat{h}_{tXX^d} = \sum_{v \in Z} W_f(v)U_X(w, t - v)U_{X^d}(w, t - v)
\]
With,

\[ U_x(w, t) = \sum_{u \in Z} g(u)X(t - u)e^{iw(t-u)}du \]

\[ U^d_x(w, t) = \sum_{u \in Z} g(u)X^d(t - u)e^{iw(t-u)}du \]

In this paper, we take \( h = 7 \) and \( T' = 20 \). We make the same choice\(^7\) as do Artis et al. (1992), Priestley (1995), Ahamada and Boutahar (2002), Ahamada and Ben Aissa (2004), Essaadi and Boutahar (2008) and Ftiti and Essaadi (2008).

According to Priestley (1988), if we have \( E(\hat{h}(w)) \approx h_t(w), Var(\hat{h}(w)) \) decreases when \( T' \) increases \( \forall(t_1, t_2), \forall(w_1, w_2), cov(\hat{h}_t(w_1), \hat{h}_t(w_2)) = 0 \), if at least one of the conditions (i) or (ii) is satisfied.

### III- Data

In this paper we use monthly data for Tunisia consumer price index (CPI) for July 1987 to December 2011 from International Monetary Fund’s International Financial Statistics Database. Then we calculated the inflation rate \( \pi \) as follows:\(^8\)

\[ \pi_t = 100 * \ln \left( \frac{CPI_t}{CPI_{t-1}} \right) \]

We note that for the evolutionary spectral estimation necessity, we lose ten observations at the beginning and at the end. So the evolutionary spectral density function of inflation is estimated from 1988(M6) to 2010(M11).

At the beginning we start by presenting the descriptive statistics of inflation rate in the following table (tab.1).

| Table 1: Summary Statistics for Tunisian inflation rate |
|------------------|-----------------|
| Mean             | 0.152           |
| Median           | 0.145           |
| Maximum          | 0.621           |
| Minimum          | -0.166          |
| Standard deviation| 0.117          |
| Skweness         | 0.561017        |

\(^7\) This choice of values is justified by the fact that they respect the conditions (i) and (ii).

\(^8\) The CPI index is seasonal adjustment according the CENSUS method X12. For more details on this method, please see Darne (2000).
Then we present the results of stationary analysis of the Tunisian inflation rate and the autocorrelation function respectively in table 2 and table 3. These two tables are useful as primary analysis of the Tunisian inflation persistence.

### Table 2: Unit root tests results for inflation series (1987-2011)

<table>
<thead>
<tr>
<th>Stationary test</th>
<th>Break points</th>
<th>Statistics</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Augmented Dickey and Fuller test statistic</td>
<td></td>
<td>-16.576</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Phillips-Perron test Statistic</td>
<td></td>
<td>-181.041</td>
<td>(0.000)</td>
</tr>
<tr>
<td>Zivot and Andrews (1992)</td>
<td>2001</td>
<td>-17.987</td>
<td>(0.000)</td>
</tr>
</tbody>
</table>

### Table 3: Autocorrelation function of inflation series (1987-2011)

<p>| | | | | | | | |</p>
<table>
<thead>
<tr>
<th></th>
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<th></th>
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</tr>
</thead>
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<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>---</td>
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<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>0.995757</td>
<td>0.988012</td>
<td>0.977057</td>
<td>0.963195</td>
<td>0.946777</td>
<td>0.928147</td>
<td>0.907638</td>
<td>0.885577</td>
</tr>
<tr>
<td>0.862210</td>
<td>0.837857</td>
<td>0.788012</td>
<td>0.763472</td>
<td>0.739297</td>
<td>0.715545</td>
<td>0.692231</td>
<td>0.669302</td>
</tr>
<tr>
<td>0.646751</td>
<td>0.624645</td>
<td>0.603025</td>
<td>0.561147</td>
<td>0.540863</td>
<td>0.520957</td>
<td>0.501538</td>
<td>0.482628</td>
</tr>
<tr>
<td>0.464254</td>
<td>0.446502</td>
<td>0.429442</td>
<td>0.413067</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### IV- Results and discussions

#### Tunisian Inflation regime
At the beginning we start our analysis by studying the Tunisian inflation regime during the last two decades. The result of evolutionary spectral analysis, explained in section 2.1, leads to the following figures of the inflation rate spectral density function respectively on short-run (4 months and 10 months) and medium term (3 years).

The following figures 1, 2 and 3 show the pattern of the evolutionary spectral density function of inflation series respectively for 4 months, 10 months\(^9\) and 3 years (this frequency reflects the medium-run).

Figure 1: The spectral density function of inflation series in short-term \(\frac{10\pi}{20}, 4\) months

![Figure 1](image1.png)

Figure 2: The spectral density function of inflation series in short-term \(\frac{4\pi}{20}, 10\) months

![Figure 2](image2.png)

Figure 3: The spectral density function of inflation series in short-term \(\frac{\pi}{20}, 3\) years

![Figure 3](image3.png)

\(^9\) These two frequencies present the short-run horizons.
According these figures we suspect different regimes of the Tunisian inflation rate. We note that the variability of inflation rate in short-run (Fig1 and Fig2) is more observed than in the medium run (Fig.3). This is we apply the Bai Perron test (1998-2003) to these different spectral density functions to determine endogenously different break points. The results of this test are presented in the following table (Table 4).

Table 4: Autocorrelation function of inflation series (1987-2011)

<table>
<thead>
<tr>
<th>Break 1</th>
<th>Short-run: 4 months</th>
<th>Short-run: 10 months</th>
<th>Medium-run: 3 years</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1990 M12**</td>
<td>1990 M2***</td>
<td>1989 M10**</td>
</tr>
<tr>
<td></td>
<td>1997 M2*</td>
<td></td>
<td>1997 M5**</td>
</tr>
</tbody>
</table>

According to this table, we show a common break occurred in all studied frequencies (short-term and medium-term) at 1990. This point is explained, in one hand by reforms undertaken by Tunisian policy makers at the end of eighty decade and, in other hand by the adoption of a new monetary policy: monetary targeting (M2).

Our analysis identifies a second break at 1996 in short-run frequency (4 months) and medium-term (3 years). This point appears very significant. Indeed, the first inflation regime (1987-1996) is characteristic by a relatively decrease of inflation compared by the previous period (eighty decade). However some author, such as Elkaram (1990), show that the monetary policy adopted in last of eighty decade had been disarmed. At the beginning of ninety decade Tunisian Central bank adopts a prudential regulation policy for banker sector. This policy leads to liquidity excess

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10 Following a balance of payments crisis in 1985-86 Tunisia started a stabilization program, as well as a structural adjustment program of economic and financial liberalization. The objective was to move from controlled economy and an administratively managed financial system towards an open and market oriented system with a reduced direct involvement of the state. Measures taken to reform the financial and banking systems since 1987 included eliminating progressively credit allocation controls by abolishing credit ceilings and preferential interest rates. Interest rates were progressively freed, but the TCB maintained a strong involvement in their determination. Reforms of the financial system included the development of non-bank financial institutions and the capital market. Like many other developing countries, Tunisia has a dual financial system: a legal financial system and an Illegal financial one. What we are more interested in here is the legal financial system, which covers the financial markets and financial institutions. Prior to 1987, Tunisia’s financial markets were rather incomplete and simple. Since that time, after the beginning of the reform era, Tunisia has been gradually trying to establish complete financial markets in order to meet the demands of the liberalization and of the sustained growth.

11 The Tunisian Central Bank is unable to act on interest rate because it has hesitated in 1988 and 1989 to what policy it is better to adopt? Stabilisation or expansionary policy?
on the economy and monetary aggregate objective in never achieved.

Consequently, in 1996 TCB decreases gradually the interest rate and revise its objective of monetary aggregate in several times (1996, 1997, and 1999). These actions taken since 1996 explained the structural break identified by our analysis in 1996. So, according our methodology, we identify three inflation regimes in the case of Tunisia. Before 1990s, Tunisian have experienced a higher inflation regime with bad macroeconomic indicators\(^{12}\). The second regime started from 1991 to 1996. This period is characterised by relatively decrease of inflation rate compared by the previous regime. However, some macroeconomics indicators are not achieved, such as the objective of monetary aggregate. The third regime, started from 1996 to 2010, reveals a more stable inflation rate. In this period the main objective of TCB consist on assuring financial stability markets.

**Tunisian Inflation persistence**

The persistence notion has an important role on the macroeconomic theory and especially in monetary theory. At the beginning of seventy decade many models are presented showing the role of persistence notion\(^{13}\) on expectations such as (Fischer, 1977; Gray, 1977; Taylor, 1980; Calvo, 1983; Rotemberg, 1982, 1983;...). Understanding inflation persistence\(^{14}\) is important for policy analysis. In other hand, inflation persistence determines the nature of inflation responses on chocks. On other hand, it determines the effect of disinflationary policy on the inflation. The literatures on inflation persistence distinguish between reduced form from the structural inflation persistence. Reduced form persistence will refer to an empirical property of an observed inflation measure, with- out economic interpretation. However, structural form consists to specify the economic sources of inflation persistence. Many measure of inflation persistence are proposed in the literature; unit-root tests, the autocorrelation function of inflation series, the sum of the autoregressive coefficients for inflation, the dominant root of the univariate autoregressive inflation process. In this paper, we will interest to the reduced form of inflation persistence. We use the autocorrelation function and unit-root test as a primary analysis of inflation persistence and a new time-varying measure via evolutionary auto-spectral analysis developed in section 2.2.

Table 2 shows the results of unit-root tests. All tests (both and without break)\(^{15}\) show that the inflation series is stationary during all period of 1987-2011. However, both the Clemente et al. (1998) and Lee and Strazicich (2004) tests indicate a structural break in the early 1991 and 1997 which coincides with The Zivot and Andrews (1992) test also confirms a structural break in

\(^{12}\) For more details, see Boughrara and Smida (2004)

\(^{13}\) Inflation persistence or output persistence.

\(^{14}\) Persistence of inflation assumes that inflation is positively correlated with its own lags, an assumption that holds up well over most of post-war history. More generally, a time series may be deemed persistent if the absolute value of its autocorrelations is high, so that a strongly negatively auto-correlated series would also be characterized as persistent.

\(^{15}\) We use three kinds of unit root tests to examine the stationarity properties of inflation series. The first kind consists on the Augmented Dickey and Fuller (1979) test and the Phillips and Perron (1988) test. However, this type of tests has been criticized by their bias towards non-rejection of the null hypothesis of a unit root against the alternative of (trend) stationary in the presence of structural breaks and low power for near-integrated processes. The second kind of tests allows for one break in the series: Zivot and Andrews (1992) test and Lee and Strazicich (2004) test. The third Kind of test allows for two breaks in the series: Clemente et al. (1998) test. This kind of test allows for two changes in the mean for non-trending additive and innovative outliers models.
Table 3 presents the autocorrelation function of Tunisian inflation series. The results show a higher degree of autocorrelation.

Figure 4: The Pattern of the Tunisian Inflation Persistence in the short-run (2 months)

![Figure 4](image)

Figure 5: The Pattern of the Tunisian Inflation Persistence in the short-run (10 months)

![Figure 5](image)

Figure 6: The Pattern of the Tunisian Inflation Persistence in the medium-term 3 years

![Figure 6](image)

According to the above graphics (4, 5 and 6), it is clearly that the Tunisian inflation has a higher degree of persistence. We show the inflation persistence is identified in the case of Tunisia both in the short-run and in the medium-run with a relatively higher degree in short-run. Indeed,
fig 4 and Fig 5 show the inflation persistence respectively for 4 months and for 10 months. These two figures show a mean of inflation persistence respectively equal to of 70% and 50%. However, the figure 6, presenting the inflation persistence on the medium-term, exhibits an average of 75%. The result of this part of the paper is very interesting which show that one of Tunisian inflation rate characteristic consists on its higher degree of persistence on the short-run and medium-run. In other word we prove that the Tunisian inflation responds gradually to shocks. Consequently on this result, in actually period with a great challenge of policy maker to reduce inflation, we suggest the using of institutional reforms to success the inflation reduction. This recommendation is motivated by previous research when the inflation has a higher degree of inertia, the monetary policy action-reduction of interest rate for example- are irrelevant to make out a disinflationary environment (authors).

V- Conclusion

The great challenge of the Tunisian policy makers, to reduce inflation and promote growth, consists of the principal motivation for this investigation. Our main objective in this study is to determine the main characteristics of the inflation series in order to determine what actions must be undertaken to success the inflation reduction. So, we are studying the Tunisian inflation rate on two dimensions. Firstly, we check the Tunisian inflation experiences regimes, then we make an investigation on the Tunisian inflation persistence. This paper is, in our acknowledgement, the first work which treats the inflation at a time on these two dimensions. In addition, we propose, in this paper, a new measure of inflation persistence. The main finding of this paper is that the Tunisian inflation series has a stable level (regime switching results), but this stability is around a relatively higher level (5%). Then, we show that the Tunisian inflation has a higher degree of persistence which traduce its gradually response on shocks.

These results are very important on the actual and future period. Indeed, after 14th September 2011, we have observed a continually higher inflation rate. Consequently to these facts, since 2011, Central Bank has managed multiple revisions of interest rate but these actions are irrelevant. Then, according our analysis and results, behind a higher degree of inflation inertia and a stable process of inflation rate around 5% in last ten year, to reduce variability and the level of the inflation rate, policy makers must undertaken structural and institutional reforms to success the process of inflation reduction.

Bibliography


