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Short-Term Forecasting Algerian Inflation using ARIMA Processes

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Abstract— **Inflation appears as a first challenge for the recent Algerian economic performance. The goal of this study is to forecast the performance of the Algerian inflation rates by applying the Box - Jenkins approach (1976) to the following series from M2 2006 to M12 2014 as full period estimation, then the full period M2 2014 to M2 2015 as an ex post forecast period and M3 2015 to M2 2016 as forecasting short-term period. ARIMA Results appear to exhibit better forecasting inflation trend with a slight real downward tendency.**

Index Terms— **inflation , forecasting, ARIMA.Model**

I. INTRODUCTION

The first half of the 1970's witnessed a stable inflation rate that oscillated between 3 to 6% that, unhappily, began to show an increasing tendency from 1975 to 1988 with an average annual inflation rate of 9.96%. This peak can be explained by many reasons including the implementation of a new Algerian exchange rate regime that is based upon a basket of 14 currencies[i] instead of the strict beg. The second reason behind the high inflation rate during the 1975-1988, is contained within the core inflation itself, as measured by the dominance of food products that contributed up to 50 % to the total increase in imports due to trade openness looseness.

Price stability, considered actually as great challenge for the bank of Algeria, has been largely impacted by CPI increase from the 90's. Average CPI inflation was 18.55% in the first decade of the estimated study (1990s). On the Contrary in the second decade 2000's, inflation had witnessed its lowest rate approximating a rate of 3.2 %. After the end of the first decade of the new millennium and the beginning of the second decade, inflation increased substantially to levels that vary between 6 to 8.5 %. During the last Five years (2010-2015), price stability benefited from a better rate compared with the two last decades that exhibited a decrease in inflation rate averaging 5%. This study uses the Markov Switching model to examine the relationship between Algerian Inflation and inflation Uncertainty using quarterly data for the period 1974-2014.

The rest of the paper is organized as follows. In section 2 we present a Review Literature the relationship between Algerian Inflation and inflation Uncertainty. Section 3 presents the Model and the Methodology. Section 4 shows the results followed by discussion. Finally, the main conclusion are drawn in the fifth section.

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II. LITERATURE REVIEW

An abundant Economic Research has focused for many decades on inflation topics, such as the main determinants of inflation; (**see Dornbusch et al. (1990)[ii], Click (1998)[iii] , Arize et al.(2004)[iv], Klein and Kyei (2009)[v], Kandil and Morsy (2011) [vi] , Ibrahim A. O and Akinwande A, (2010)[vii]).** Other studies highlighted the relationship between inflation and economy growth. **Baroo (1991)[viii], Bruno and Easterly (1998)[ix], Khan and Senhadji (2001)[x], Nicholas (2009)[xi]…**

Inflation uncertainty is still also considered as a theoretical subject, **Okun (1971)[xii]** and **Friedman 1977**, **Ball 1990[xiii]** argued that high inflation creates more uncertainty about future inflation. This is called the Friedman Hypothesis that gave rise to many empirical investigations interested in the estimation of the relationship between inflation and Inflation uncertainty. **See: Fisher (1981) [xiv], Taylor (1981)[xv], Ball and Cecchetti (1990)[xvi]**. On the contrary of Friedman Hypothesis, **Pourgerami and Maskus (1987) [xvii]** found a negative relationship between inflation and inflation uncertainty.

G. Moser et al (2007)[xviii] compared the performance of factor models with VAR and ARIMA models for the forecasting of 12-step-ahead out-of-sample prediction of the harmonized index of consumer prices (HICP). Their results suggested that VAR Model outperforms better compared with a forecast of headline inflation itself.

On the contrary, Meyler et al (1998) [xix] found an appropriate ARIMA technique compared with the objective of a penalty function method for forecasting Irish inflation.

Pufnik and Kunovac (2006)[xx] developed Seasonal ARIMA Processes for a Short-Term Forecasting of Inflation in Croatia that exhibited good performances.

Suleman and Sarpong (2012)[xxi] predicted an 11 months forecast for the year 2012 in Ghana using ARIMA model. The Diagnostic test of the model residuals indicates some good forecasting results with slight volatility in the inflation pattern.

Baciu (2015) [xxii] used autoregressive processes, moving average processes (ARIMA) for forecasting the inflation rate in Romania during the period from January 1997 to August 2013. He succeeded in his estimation of the inflation rate for September 2013 that turned around 3.01 %.

III. MODEL AND METHODOLOGY

Definition of Autoregressive Integrated Moving Average - ARIMA

Autoregressive-Integrated-Moving Average Models (ARIMA) are the most famous models applied for the prediction of future trends by using time series data. This tool was developed in **1976** by statisticians **George Box and Gwilym Jenkins** [xxiii] on the basis of non-stationary time series. The Box-Jenkins approach combines past autoregressive values (AR) and past error terms (moving average: MA) in order to identify the Rank (p, d, q) of ARIMA model as follows**:**

$$\Delta p_t = \phi_1 \Delta p_{t-1} + \phi_2 \Delta p_{t-2} + \ldots + \phi_p \Delta p_{t-p} + \varepsilon_t + \theta_1 \varepsilon_{t-1} + \theta_2 \varepsilon_{t-2} + \ldots + \theta_q \varepsilon_{t-q}$$

A R M A

Where *p* and *q* give the number of autoregressive and moving average terms, respectively, and Δ denotes the first difference. The error term □$_t$ is assumed to follow a white noise process with variance □^{2}. **See Huwiler and Kaufmann (2013)**[xxiv]**.**

After identifying the number rank of ARIMA model and checking for the existence of the white noise in the residuals that are estimated from ARIMA, the next step involves series forecasting based on the ARIMA model.

Results and Comment

Much econometric estimation, which use the least square method (GLS) produce spurious regression and their statistics indicate false and bias elasticity (**Granger and Newbold, 1974)**[xxv]**).** In this paper, **Augmented Dickey-Fuller (1979,**[xxvi] and **Phillips and Perron, (1988)**[xxvii] tests drawn from the stationary tests represented in figure below, allow a rejection of the null hypothesis in the first difference that signifies no stationary in all our series, but enables an acceptance at a level that signifies integration of the variables at order 1.

Table 1: ADF and PP Unit Root Tests

Variables	Augmented Dickey Fuller (ADF)			
	Level		First difference	
	intercept	Trend and intercept	intercept	Trend and intercept
Inf	-2.67	-2.63	-9.305***	-9.326***
	Phiilips Perron PP			
inf	-2.64	-2.55	-9.368***	-9.462***

*show values are significant at 5 % level with MacKinnon (1996).

**show values are significant at 1% level with MacKinnon (1996).

***show values are significant at 5 % and 1 level with MacKinnon (1996).

The two tables below preset the autocorrelation and partial correlation functions for identifying the rank of p and q at first difference level respectively by plotting correlogram test and Q-statistics stages for Box–Jenkins autoregressive moving average time series models. This first results of the analysis confirmed a non stationary inflation variable at level and checking the autocorrelation and partial autocorrelation function at first difference shows the fits of the inflation time series near to zero and a drop inside the confidence bands (statistically significant at 5% at first difference).

Table 2: the autocorrelation and partial correlation functions

Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob
.|******|	.|******	0.885	0.885	84.625	0.000
.|***** |	*|. |	0.758	-0.119	147.24	0.000
.|***** |	.|* |	0.670	0.114	196.63	0.000
.|**** |	.|. |	0.590	-0.034	235.41	0.000
.|**** |	.|* |	0.542	0.121	268.44	0.000
.|**** |	.|* |	0.527	0.111	299.98	0.000
.|*** |	*|. |	0.480	-0.141	326.35	0.000
.|*** |	*|. |	0.406	-0.083	345.48	0.000
.|** |	*|. |	0.314	-0.152	357.02	0.000
.|* |	*|. |	0.196	-0.177	361.57	0.000
.|* |	*|. |	0.086	-0.091	362.45	0.000
.|. |	*|. |	-0.008	-0.128	362.46	0.000
.|. |	.|* |	-0.039	0.194	362.65	0.000
.|. |	.|. |	-0.042	0.047	362.86	0.000
*|. |	*|. |	-0.080	-0.121	363.66	0.000
*|. |	.|. |	-0.128	0.021	365.73	0.000
*|. |	*|. |	-0.190	-0.094	370.32	0.000
**|. |	.|. |	-0.262	-0.007	379.15	0.000
**|. |	.|* |	-0.268	0.210	388.53	0.000
**|. |	.|. |	-0.242	-0.009	396.26	0.000
**|. |	.|. |	-0.215	0.057	402.47	0.000
*|. |	.|. |	-0.184	-0.043	407.05	0.000
*|. |	.|. |	-0.166	-0.039	410.81	0.000
*|. |	.|. |	-0.181	-0.054	415.34	0.000
*|. |	.|* |	-0.170	0.116	419.41	0.000
*|. |	.|. |	-0.150	0.026	422.61	0.000
*|. |	.|. |	-0.116	0.015	424.53	0.000
.|. |	.|. |	-0.054	0.023	424.95	0.000
.|. |	.|. |	0.005	-0.026	424.95	0.000
.|. |	*|. |	0.033	-0.098	425.12	0.000
.|. |	.|. |	0.042	0.035	425.38	0.000
.|. |	.|. |	0.027	-0.054	425.50	0.000
.|. |	.|. |	0.012	-0.034	425.52	0.000
.|. |	*|. |	0.008	-0.074	425.53	0.000
.|. |	.|. |	0.025	0.010	425.63	0.000
.|. |	.|. |	0.050	-0.054	426.03	0.000

Table 03 : Q-statistic probabilities

Autocorrelation	Partial Correlation	AC	PAC	Q-Stat	Prob
. |. |	. |. |	-0.009	-0.009	0.0074	
**|. |	**|. |	-0.250	-0.250	6.0263	
. |. |	. |. |	-0.021	-0.028	6.0701	0.014
. |. |	.*|. |	-0.004	-0.071	6.0713	0.048
.*|. |	**|. |	-0.189	-0.218	9.6340	0.022
. |. |	. |. |	-0.01	-0.05	9.6640	0.04

<table>
<tr><td></td><td></td><td>7</td><td>4</td><td></td><td>6</td></tr>
<tr><td>. |. |</td><td>.*|. |</td><td>0.043</td><td>-0.078</td><td>9.8502</td><td>0.080</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>0.060</td><td>0.020</td><td>10.217</td><td>0.116</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>0.135</td><td>0.125</td><td>12.111</td><td>0.097</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>0.022</td><td>0.014</td><td>12.163</td><td>0.144</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>0.077</td><td>0.169</td><td>12.800</td><td>0.172</td></tr>
<tr><td>.*|. |</td><td>. |. |</td><td>-0.098</td><td>-0.065</td><td>13.830</td><td>0.181</td></tr>
<tr><td>.*|. |</td><td>. |. |</td><td>-0.102</td><td>-0.015</td><td>14.978</td><td>0.184</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>0.108</td><td>0.157</td><td>16.265</td><td>0.179</td></tr>
<tr><td>.*|. |</td><td>.*|. |</td><td>-0.137</td><td>-0.191</td><td>18.362</td><td>0.144</td></tr>
<tr><td>.*|. |</td><td>.*|. |</td><td>-0.173</td><td>-0.103</td><td>21.759</td><td>0.084</td></tr>
<tr><td>. |* |</td><td>. |. |</td><td>0.109</td><td>-0.021</td><td>23.123</td><td>0.082</td></tr>
<tr><td>. |. |</td><td>.*|. |</td><td>0.019</td><td>-0.173</td><td>23.167</td><td>0.109</td></tr>
<tr><td>.*|. |</td><td>.*|. |</td><td>-0.101</td><td>-0.091</td><td>24.383</td><td>0.109</td></tr>
<tr><td>. |* |</td><td>. |. |</td><td>0.081</td><td>-0.064</td><td>25.177</td><td>0.120</td></tr>
<tr><td>. |* |</td><td>. |. |</td><td>0.120</td><td>0.038</td><td>26.928</td><td>0.106</td></tr>
<tr><td>. |. |</td><td>. |* |</td><td>0.060</td><td>0.138</td><td>27.373</td><td>0.125</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>-0.035</td><td>0.005</td><td>27.527</td><td>0.154</td></tr>
<tr><td>**|. |</td><td>.*|. |</td><td>-0.223</td><td>-0.127</td><td>33.858</td><td>0.051</td></tr>
<tr><td>.*|. |</td><td>.*|. |</td><td>-0.121</td><td>-0.115</td><td>35.740</td><td>0.044</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>0.022</td><td>-0.040</td><td>35.802</td><td>0.057</td></tr>
<tr><td>. |. |</td><td>.*|. |</td><td>-0.064</td><td>-0.106</td><td>36.354</td><td>0.066</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>0.060</td><td>-0.053</td><td>36.842</td><td>0.077</td></tr>
<tr><td>. |. |</td><td>.*|. |</td><td>0.068</td><td>-0.080</td><td>37.472</td><td>0.087</td></tr>
<tr><td>. |. |</td><td>.*|. |</td><td>0.016</td><td>-0.076</td><td>37.506</td><td>0.108</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>0.173</td><td>0.104</td><td>41.729</td><td>0.059</td></tr>
<tr><td>. |. |</td><td>. |. |</td><td>-0.002</td><td>-0.016</td><td>41.729</td><td>0.075</td></tr>
<tr><td>.*|. |</td><td>. |. |</td><td>-0.175</td><td>-0.002</td><td>46.202</td><td>0.039</td></tr>
<tr><td>.*|. |</td><td>. |. |</td><td>-0.095</td><td>-0.061</td><td>47.551</td><td>0.038</td></tr>
<tr><td>. |* |</td><td>. |* |</td><td>0.099</td><td>0.098</td><td>49.046</td><td>0.036</td></tr>
<tr><td>.*|. |</td><td>. |. |</td><td>-0.069</td><td>-0.031</td><td>49.792</td><td>0.039</td></tr>
</table>

Test of heteroskedasticity

Breusch-Godfrey Serial Correlation LM test accepted the alternative hypothesis that Chi-Square is more than 0.05. The same results we detected for Q-statistics which are greater to the level meaning there are no autocorrelation errors and allows the model to become pertinent to forecasting purposes.

Table 04 : Breusch-Godfrey Serial Correlation LM Test:

F-statistic	2.902302	Prob. F(2,87)	0.0602
Obs*R-squared	5.487231	Prob. Chi-Square(2)	0.0643

The final step consists of forecasting the future values of the inflation rate by using past values of the inflation rates. Usually we go through a series from M2 2006 to M12 2014 as a period estimation and resample the full period M2 2014 to M2 2015 as an ex post forecast period and M3 2015 to M2 2016 as forecasting in short-term future over one year . Then, we compare forecasts of the ARIMA model in real time (2015) and future time (2016) for the total inflation period by using Root Mean Squared Error and Theil Inequality Coefficient.

Diagnostic of ARIMA forecasting results seems to give good evaluation, considering that the F-Statistic of the Regression of the Root Mean Squared Error and the Mean Absolute Error are significant. This important result can be confirmed by Theil Inequality Coefficient which is significant at 5%.

The main result is that the Algerian inflation can be predicted on the basis that it contains information about future inflation trend, see **figure 1 and 2.**

Figure 01: inflation forecasting

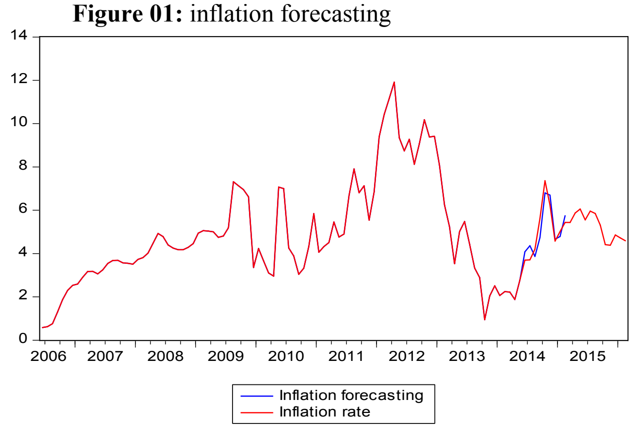
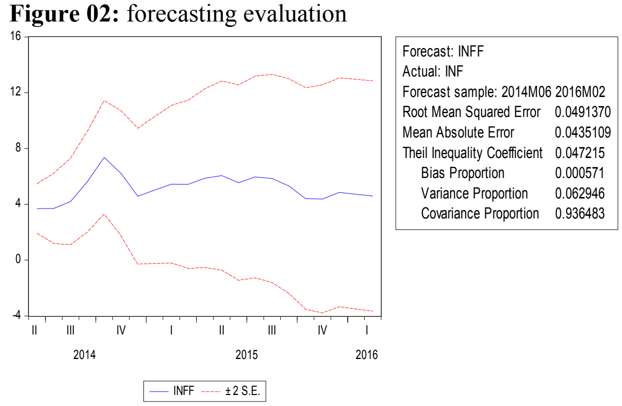


Figure 02: forecasting evaluation



Conclusion

Inflation has witnessed its lowest average at 3.2 %. After the end the first decade of the new millennium and beginning of the second decade, inflation was characterized by an increase in its rate to levels that range between 6 to 8.5 %. The Main findings allow to advance that inflation rate in Algeria will present some moderate stability in the future.

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