

Forecasting Algeria's Unemployment Rates Using SARIMA Model in Python Programming: During 2001-2021

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Abstract:

Unemployment is one of the major economic, social and political problems that all the countries of the world are seeking to reduce its severity and to guard against his negatives effects on economy. On that basis, this study aimed to model and to forecast monthly unemployment rates in Algeria using Seasonal Auto Regressive Integrated Moving Average Model (SARIMA), which is one of the crucial and most widely used forecasting models for univariate time series data forecasting that takes into account seasonal elements. Depending on modern python programming, the expected results indicated that among the suggested models, SARIMA Model (5.1.3) (1.0.0) has got good performance, and it has been statistically accepted. The forecasting findings during the 12 months of 2021, indicate that a steady enormous increase of the unemployment rates.

Key Words : Forecasting, Algeria's Unemployment Rates ,SARIMA Model ,Python Programming, Covid-19 Pandemic.

JEL Classification: C53 , C22 ,J64

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1. INTRODUCTION

All current studies are based on high accurate and efficient scientific standards and basis, aiming at building its plans and getting effective and desired results at all practical life areas (حمدي, 2013, p. 190). Time series analysis process is considered as one of the major scientific statistical methods that have been utilized for future forecasting of economic phenomena data, so that time is a key element with an instrumental role (significant influence) inter alia, of economic transformation and changes (وهيب, 2013, p. 2015). In view of unemployment's variations determinants and interpreting economic theories multiplicity, it is considered as one of the major issue that the entire countries are seeking to resolve it. (مجلخ, 2016, p. 58) what got the intellectuals to emphasis on handling such problem through providing employment market flexibility; therefore, reducing its rates. (مدللة, 2018, p. 497)

As all countries, Algeria is afflicted by the unemployment issue. In the 1980s, the national economy has experienced an economic growth regression with an eco-financial deterioration, which led to the need to apply a set of economic reforms to reduce the internal and external substantial financial distortions. One of the major objectives of this reforms is to reduce the employment rates increase throughout changing the majority of the economic variations structure and proceeding to the privatization process of some sectors. (عقون, 2010, p. 2)

The present research paper is seeking to answer the following research question: **How effective has Seasonal Auto Regressive Integrated Moving Average Model (SARIMA) on forecasting monthly unemployment rates in Algeria using Python Programming?**

2. Literature Review

In 2014, (Otu.al, 2014) many researchers had presented a study that included the application of SARIMA models to modeling and forecasting the inflation rates in Nigeria based upon adequate standards and after undertaking diagnostic tests, SARIMA Model (1.1.1) (0.0.1)₁₂ is selected as the best models among the suggested models. The reached results indicated the existence of a decreasing pattern during the first quarter of 2014 with a tipping point in the second quarter of the same year.

A study entitled: "Forecasting Greece's Unemployment Rates Using SARIMA Model" (Dritsaki, 2016). This research study aimed at searching for the most appropriate model to modeling monthly unemployment rates. To estimate covariance matrices, Box-Jenkins Methodology and GPG Method have been adopted. A Dynamic procedure and a static procedure have been used to forecast, and depending on forecasting accuracy measures, their results have been compared. The findings indicated that the unemployment expected values are close proximity to the exact values, where

SARIMA (0.2.1) (1.2.1) that has not affected by Arch, had been adopted among the suggested models. The obtained comparison results of the two procedures indicated that the static procedure is better and too accurate in the forecasting process.

The polish scholar (BĘDOWSKA-SÓJKA, 2017) conducted a research study about unemployment rates expectations: Earmarked Elements against SARIMA Model: Central and Eastern European countries as a Case Study. This research study aimed to compare monthly unemployment rates data accuracy between Seasonal Auto Regressive Integrated Moving Average Model (SARIMA) two models and unearmarked elements Models (UC) within a short-term incremental prediction experiment to undertake out of sample test. The selected countries are: Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia. Through the obtained findings, there is not much difference between both methods forecast accuracy in Slovenia and Slovakia, in contrast with the remaining countries, as: Hungary concerning the outperformance of the unearmarked element model compared to SARIMA model. So, the predictability is completely different between one month prospect case and 12 months prospect case.

Also, (Pratiwi.al, 2019) had conducted a research study entitled: “Predicting Farmers Exchange Rate Process in Bali Province Using Seasonal Auto Regressive Integrated Moving Average Model (SARIMA)”. This research study is aimed at predicting FER Monthly Rate of Bali Province and calculating farmers' purchasing power. Four SARIMA Models had been tested, namely, SARIMA (0.1.3) (0.1.1)₁₂, SARIMA (3.1.0) (0.1.1)₁₂, SARIMA (0.1.3) (1.1.0)₁₂, and SARIMA(3.1.0) (1.1.0)₁. Based on the AIC values results, SARIMA (3.1.0) (0.1.1)₁₂ model has been designated as the best model to exchange rate prediction.

In 2020, different scholars as Nandia Rani, Woro Tri, Handayani, and others (Handayani.al, 2020) had addressed a research study entitled: “Chronological Catfish Sales Prediction Using SARIMA Model”. This latter had been applied in SITRAN System, which has two functions; the first function is to design physical data model PDM, which includes two major tables: Table of sales movements containing total sales and sale dates, and the second table contains how many fish and fish amount in the trading process. 400 data from monthly sales have been used in the estimating and forecasting process, and 100 catches to choose accuracy prediction. The forecasting findings indicated that SARIMAX (21.2.0) (1.0.0.12) model has a good and accurate performance according to RMSE values.

Besides, in 2020, (Klutse, 2020) presented a research study entitled: “Forecasting Developing Economies Inflation Using SARIMA Models: Ghana as a Case Study”, using three methods. The first method is based on simple inflation, which is the simple model. The second method is based on General Consumer's Price Index (i.e. Combined price index), which is an intermediate model. The third method uses Consumers Price

Index for foodstuffs and non-food items inflation to determine general inflation expectations, which is the complex model, where the SARIMA model has been applied in all cases and its findings were compared with the ARIMA model. The expected findings indicated that the SARIMA model is better at forecasting inflation due to its seasonal elements. It was also found that the complex model comprising consumers' price index for foodstuffs and non-food items inflation is better than other models.

In 2020, (Edanur Kılıç, 2020) had presented a research study that discuss the application of ARIMA and SARIMA models as well as those associated with GARCH volatility models; in order to forecast adjusted seasonal unemployment rates data in the G-7 countries. The selected countries were: Canada, France, China, Germany, Italy, the United Kingdom and the United States of America. The Horizontal forecast errors and the prior forecast for 4 and 8 quarters were counted and the expected results surpass GARCH models performance in the previous four quarters forecast. For the prior forecast of eight quarters, SARIMA model surpasses the non-seasonal ARIMA model in the off-sample forecast, and SARIMA-GARCH model was selected as the best forecast model, in terms of accuracy in all countries except France, Italy.

In 2021, (Wan Nurul Ain binti Wan Marzuki, 2021), also, studied the Seasonal Auto Regressive Integrated Moving Average Model (SARIMA) to forecast tourist arrival in Malaysia, which aimed to apply this model to predict tourists arriving number in Malaysia. The research study data were monthly, and through the diagnostic test results and using appropriate criteria. SARIMA (1.1.1)(1.1.1)₁₂ model was selected as the best appropriate model to forecast the tourist arrival among of the five suggested models, namely: SARIMA(.1.1)(0.1.1)₁₂ , SARIMA(1.1.1) (0.1.1)₁₂ , SARIMA(1.1.0)(1.1.0)₁₂, SARIMA(2.1.1)(1.1.1)₁₂ .

Also, (Gulder KEMALBAY, 2021) had presented a research study entitled: "SAREMA-GARCH Versus Genetic Programming in Stock Price Forecasting". This research study aimed at forecasting Istanbul National Daily Stock Exchange Index (XU100) Using genetic programming (GP method) with SARIMA model and comparing their results based on forecast accuracy standards. The diagnostic results of SARIMA model indicate that it suffered from the Arch effect, thus the designated model was SARIMA (1.1.1) (2.0.1)₁₂ ARCH (1). The comparison results of the two applied models indicate that the GP method surpassed SARIMA model, where the former recorded better forecasting results.

In the same year, (Mwana Said Omara, 2021) had presented a research study entitled: "Comparing Holt-Winters Model with SARIMA Model: Forecasting Using NDVI in an Arid Region in Kenya. This research study aimed at forecasting the Vegetation Monthly Average Index (NDVI) in an arid region in Kenya using two models. The first model is Holt-Winters model and the second is SARIMA model. The

performance of these models was compared based on forecast accuracy standards (MAE and RMSE). The results indicated that the Seasonal Auto-regression of Moving Averages Model (SARIMA) (1.0.1) (0.0.2)₁₂ that did not excel Holt-Winters model.

In addition to the presented research study of (Davidescu.al, 2021), in which they carried out a comparative analysis of various single-variable forecast methods, as well as, modeling and forecasting the unemployment rate in Romania during 2021-2022. This study aimed at carrying out comparative analysis of different single-variable time series methods expected performance to obtain future accurate forecast of monthly unemployment rates. The models are: SARIMA Model, Autoregressive Threshold Model SETAR, Holt - Winter Model, ETS Model (Error, direction and seasonality), and NNAR model (neural network Auto Regression). Based on forecast accuracy measures results that are represented by RSME, MAE, NNAR model possesses better performance, while the MAPE scale results have indicated the surpassing of SARIMA model, whereas out-of-sample prediction results surpassed the NNAR model, and the surpassing of Holt Winter model in the in-sample forecast.

Furthermore, the research study of Virtue (2021) was about forecasting the future monthly market value of the Traditional Malaysia Stock Exchange using exact scientific method: Python Programming, and the application of SARIMA model. Based upon the obtained results, SARIMA (1.1.0) (0.1.1.12) model was selected among the suggested ones, and it surpassed in all diagnostic statistical tests. Depending on the forecast findings (for the next two years), future market deterioration is likely to be monitored.

Moreover, the research study of (Nainchi, 2021) discussed the forecast of global soybean price time-series using SARIMA and NARNN hybrid models. This research study aims to apply sophisticated techniques to forecast soybeans' monthly global prices. Based on Forecast Error Average MSE results, SARIMA Model, NARNN-LM Model, and the Hybrid-LM Model had been compared. The obtained results indicated that the excellence of the hybrid model of eight neurons in the hidden layer with three time delays, as opposed to NARNN-LM model of eight neurons in the hidden layer and three time delays as well. Also, the surpassing of SARIMA model (0.1.3) (0.0.2), so that the hybrid model has the potential for linear and non-linear modeling; therefore, it is a good option for time-series modeling.

Similarly, (Yahya.al, 2021), attempted to obtain an appropriate model to forecast monthly rainfall patterns in South East of Sulawesi in Indonesia; in order to set up a rice farming calendar using the Moving Averages Seasonal Auto-regression Model. By following SARIMA model setting up steps and comparing the suggested models, it had been indicated that SARIMA (0.0.0)(0.1.3)₁₂ Model has a good and accurate performance in the forecast process. Based on the approved model forecast findings, it was found that the highest rainfall would be in January, July, November and December,

i.e. It is the appropriate period for each year planting process, while September and October must be avoided.

3. Theoretical Part

3.1 Time -Series Models

Both Moving Averages Auto-regression Models and Integrative Moving Averages Auto-regression Models are defined as sequential or non-seasonal models, where the present value has been expressed with prior values significance or a number of consecutive previous random changes, or both together. For seasonal models, it goes in the season effect and the present value is expressed as the same season values of previous years, or as the same season random changes, or both, as well as the current random change of all models (عدنان كريم نجم الدين, 2018, p. 32).

3.2 Seasonal Integrative Moving Averages Auto-regression Model (SARIMA)

Time-series is defined as a statistical variable sequence over equal periods of time, whether a year, a month or even a week. Often, time-series models have been used to study economic phenomena, so that their previous manners are studied, and then the Forecast Processes is assisted by setting up a special model. (فراحي, 2021, p. 285)

In fact, time-series include quarterly elements, and this leads to increase (p) and (q) values, where the estimate process becomes difficult. On this basis, a mixed model containing the seasonal formula called SARIMA model (فاتح, 2014, p. 77) that has been setting up and could be expressed in the following mathematical formula (مختار, 2020, p. 124):

$$X_{t-1} - \varphi X_{t-s} - \varphi_2 X_{t-2s} - \cdots - \varphi_p X_{t-ps} = \varepsilon_t - \theta_1 \varepsilon_{t-s} - \theta_2 \varepsilon_{t-2s} - \cdots - \theta_q \varepsilon_{t-qs}$$

3.3 SARIMA Setting up Steps According to Box-Jenkins Methodology

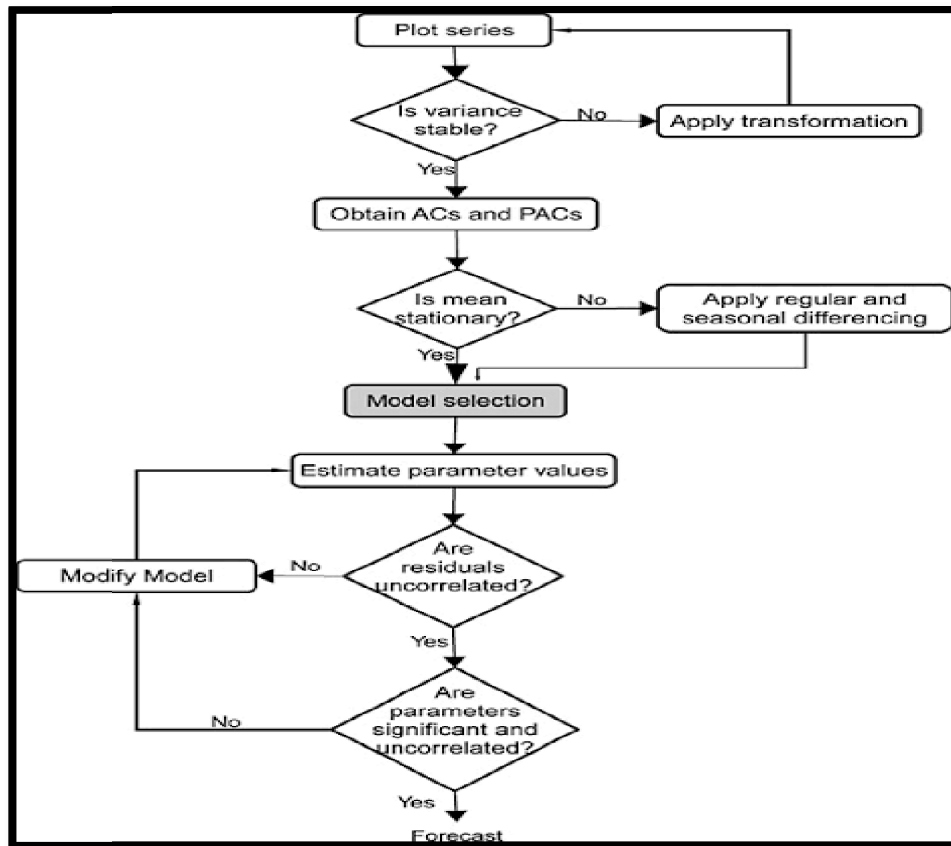
To set up SARIMA model according to Box-Jenkins Methodology, the following four phases must be followed (كمال سلطان محمد سالم, 2019, p. 476)

- 1- **Recognition Phase:** Both (p.d.q) and (P.D.Q) values must be determined. As Box-Jenkins methodology requires time-series inactivity, data study stability must be tested by applying unity root tests (whether ADF or P.P.), as well as reliance on Autocorrelation function and partial Autocorrelation function.
- 2- **Model Estimation Phase:** After selecting the appropriate model based on the appropriate criteria, the mathematical equation representing the studied phenomenon is presented.

3- **Model Diagnosis Phase:** The estimated model residue test randomness gets processed through normality distribution test; Random errors Autocorrelation test; Disparity Heterogeneity test.

4- **Forecasting Phase:** At this stage, the forecasted values are compared to the actual values of the studied series, and once the model's efficiency and ability to simulate the original series are confirmed, the future forecasting process is relied upon this model.

Fig.1. Box-Jenkins Methodology



Source : <https://pt.slideshare.net/vaibhavagarwal75436/box-jenkins-method-of-forecasting>

4. Practical Part

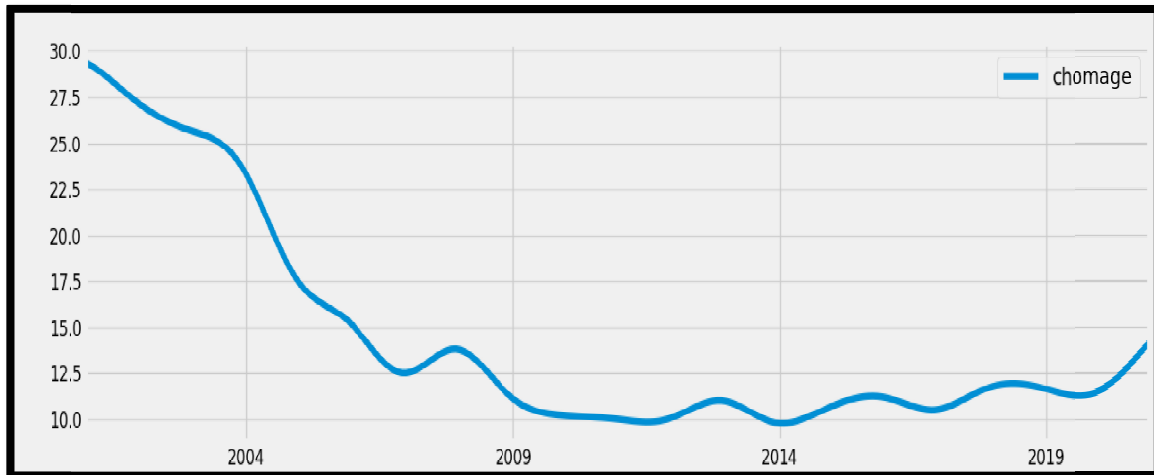
The research study data are about Algeria's monthly unemployment rates during January 2001 - December 2020, which are obtained from kneoma website. So That modern Python programming and 9reviews programme were used to carry out the modeling and the forecast process.

1. Algeria's Unemployment Data Analysis

The figure below shows Algeria's unemployment rates progression curve, during January 2001-December 2020. The diagram indicates that Algeria has undergone a noticeable economic phenomenon rates reduction at the beginning of the study period until 2008, owing to the economic reforms adopted by the Algerian Government during

the 1990s. After which unemployment rates know ongoing rise and fall until 2019. By the beginning of 2020, we have noticed that unemployment rates are constantly increasing at high levels, due to COVID-19 pandemic widespread.

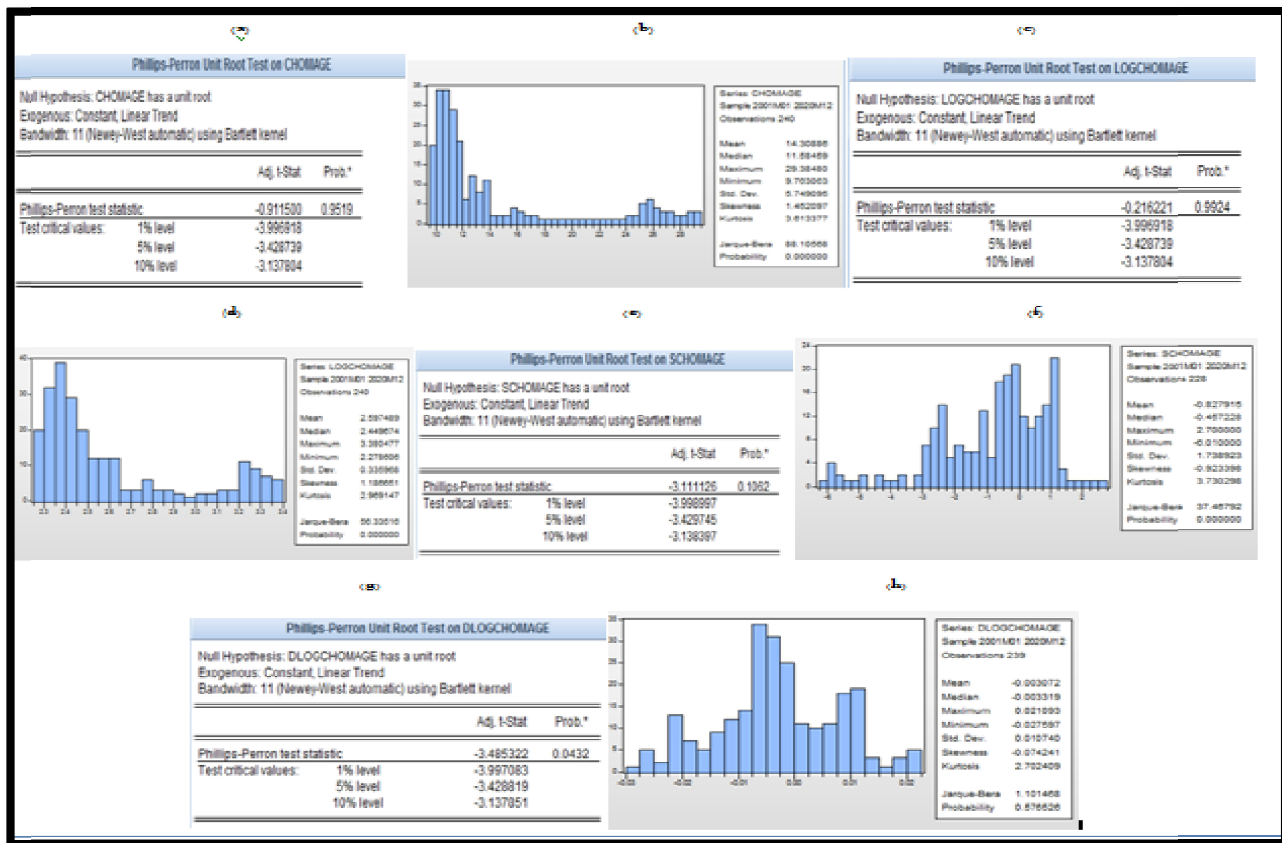
Fig.2. Monthly Algeria's Unemployment Rates Diagram
(During January 2001 - December 2020)



Source :By the researchers using Python programming (3.8.10)

2. Time -Series Stability Research Study

At this stage, unemployment rates series were studied and discussed using Phillips-Perron test and the Normality test. According to Fig (03) findings, the time- series proves to be unstable when taking the natural logarithm (Logchomage). Also, time-series instability was confirmed at the level indicated in graph (a) and (b) at a significant degree of 5% and 10%, that undergoing a stabilizing when taking the first variance of normal logarithm (dlogchomage that is illustrated in the digram (g)), after taking the seasonal variances (Schomage) and the first variance (DALG). After that, the alternative hypothesis which stipulated the unity root lack was accepted (At a significant degree of: 5% and% 10). Considering the applied original and converted time-series Normality tests, their findings correspond to those of Phillips-Perron statistical test, and the unemployment rates series converted in dlogchomage figure, are under the normal distribution that is indicated in diagram (h).

Fig.3. Test's Findings of the Unemployment Rates Series Stability

Source :By the researcher using Eviews 9 programme outcomes

3- The Appropriate Model Identification and Estimate Phase

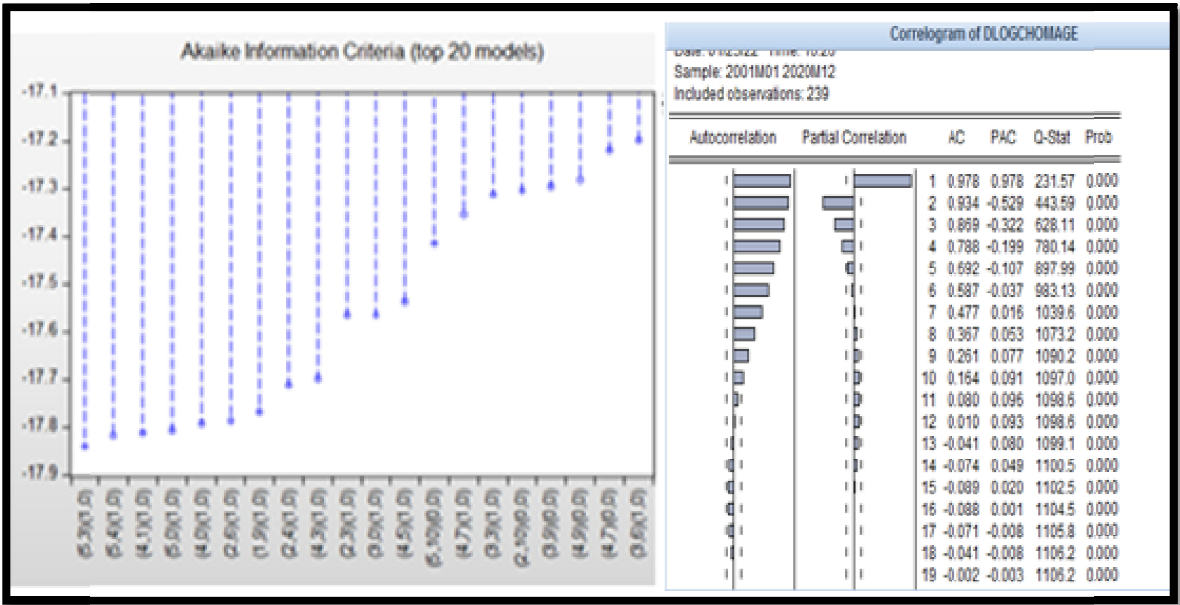
The usual method is determining the stability degree and constant disclose of autocorrelation function and partial autocorrelation function to point marks' levels of the statistical significance, but using the data method to arrive at optimal markers in the SARIMA models is not enough. The same thing with other methods; therefore, most current studies are based on the synaptic research method included in modern Python Programme (Safe Grid with optimal complexity, 2019), which uses the statmodels function. This method is regarded as an easy method to obtain acceptable model markers. The moving averages degree in this method must be less than '2' and the Auto-regression parameters are assumed. Then, an optimal model containing the lowest error box is obtained after several stages (Space, 2021, p. 288).

Considering the moving averages degree in our study is surpassing the value (2), optimal auto-regression moving averages values coefficients were determined by the evIEWS9 Programme. After the blending process, modern Python programming was used in the modelling and forecast process to obtain the best SARIMA model corresponding to the unemployment series data.

Depending upon the Simple Autocorrelation and Partial Autocorrelation functions of the dlogchomage Series illustrated in Figure (04), 239 SARIMA models were

proposed, and SARIMA (5.1.3) (1.0.0) model was selected as the best representative model, according to the smallest value of AKAIKE standard of the Unemployment Rate Series.

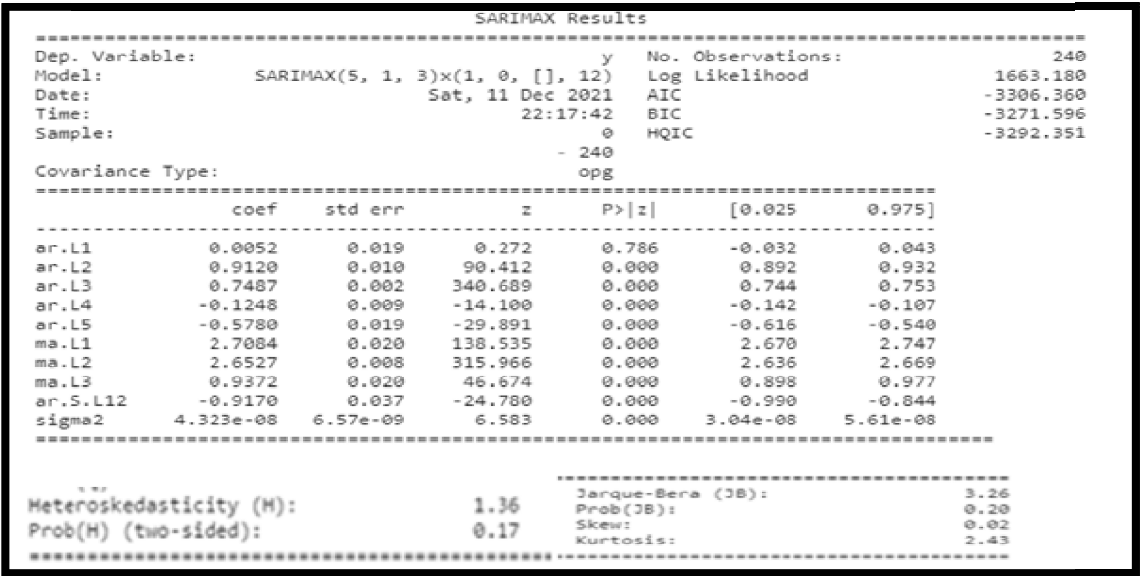
Fig.4. Proposed SARIMA Models through ACF-PACF Function Diagram (dlogchomage)



Source :By the researcher using Eviews9 program outcomes

According to the data shown in figure (05) that illustrates SARIMA (5.1.3) (1.0.0) model estimate findings, all its parameters are statistically significant at significant degrees: 1%, 5% and 10%, with all estimated model parameters within the specific confidence area except the first delay factor (ar.L1).

Fig.5. SARIMA (5.1.3) (1.0.0) Model Estimate Findings



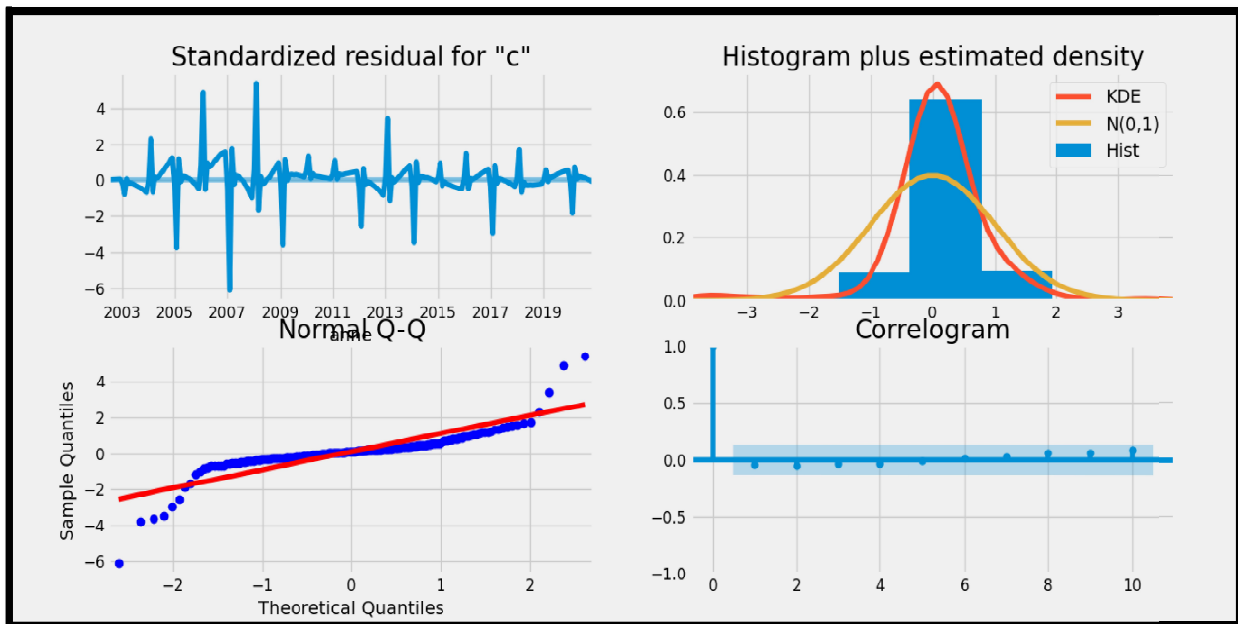
Source : By the researchers using Python Programming

4- Model Diagnosis Phase

At this stage, the findings of the autocorrelation test for random errors test, the normality test and the disparity homogeneity test have been ascertained. Based on figures (05) and (06) results, the following hypotheses have been checked out:

- All estimated model parameters have statistical significance at significant degree: 1%, 5% and 10%, except for the first parameter expressing (ar.L1) variable.
- The Jarque-Bera normality test reached the value of 3.26 at a possible level of 0.20, which is greater than 5%, so the estimated model residue follows the normal distribution.
- Throughout the illustrated graph in Figure (05) (on the bottom right) (correlogram), the model does not have a problem with the random errors autocorrelation.
- The disparity heterogeneity value test reached 1.36 at a potentiel level of 0.17, which is greater than 5%. These findings affirm that the estimated model does not have a disparity heterogeneity problem, i.e. affirming the nihilistic hypothesis, which sets out that error disparity is constant over time, has been accepted.

Fig.6. Normality Test and Random Errors Autocorrelation



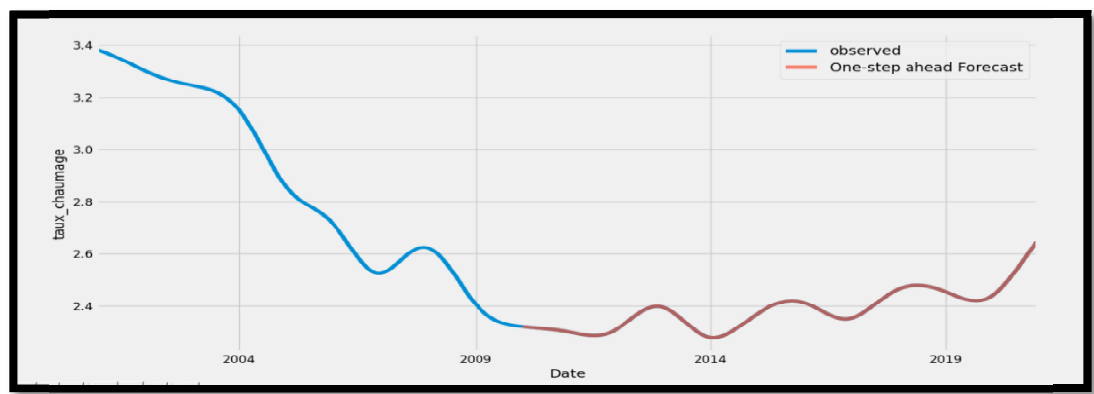
Source :By the researchers using Python Programming (3.8.10)

5- Forecasting Phase

Based on the diagnostic phase findings, the estimated model is statistically accepted, and to ascertain the efficiency of this model in unemployment rates future forecasting process, the exact and forecasted series during 2010-2020 has been

compared. Figure (07) indicates that the predicted series emulate the unemployment rates original series in a good and accurate manner, and the selected model can be used to forecast the future unemployment rates.

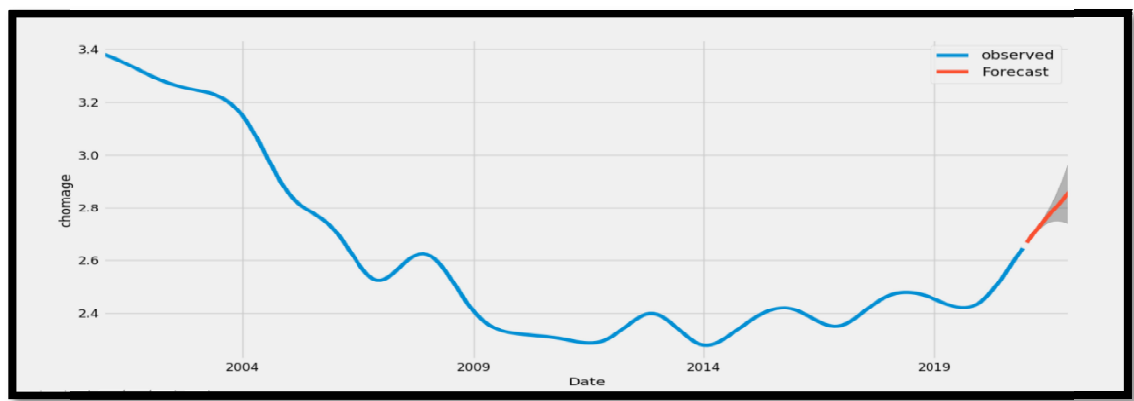
Fig.7. Comparing Unemployment Rates Original Series with Predicted Ones



Source : By the researchers using Python Programming (3.8.10)

Figure (08) exhibits the unemployment rates original series, attached to the future unemployment rates for 2021. It indicates that unemployment rates are steadily increasing, owing to the negative impact of Covid-19 epidemic on national economy, particularly the labour market, which reached skyrocketing unemployment rates.

Fig.8. Predicted Unemployment Rate Diagram Using SARIMA (5.1.3) (1.0.0)



Source :By the researchers using Python Programming (3.8.10)

Despite conducting urgent measures and procedures by the Algerian Government, namely: functioning distance working mechanism, part-time working mechanism and so on, and based on the findings of Table (01), which presents the expected values of the monthly unemployment rates for 2021, This latter is still exist. By reference to the findings of table 01 that reviews their expected values, prove to be 17.43 % in December 2021 compared to the unemployment rate ratios in February 2020. This period is the birth of Covid-19 epidemic prevalence, and we have noticed that unemployment rate ratios intensity was exacerbated awfully, which would require reflecting on other economic, social and health measures.

Table 1. Monthly Unemployment Rate Values of 2021

Time-Period	Unemployment Rates
01/01/2021	14,3906
01/02/2021	14,6788
01/03/2021	14,9627
01/04/2021	15,241
01/05/2021	15,5135
01/06/2021	15,7809
01/07/2021	16,0449
01/08/2021	16,3081
01/09/2021	16,5739
01/10/2021	16,8464
01/11/2021	17,1304
01/12/2021	17,4311

Source :By the researchers using Python Programming (3.8.10)

5. CONCLUSION

Unemployment phenomenon is one of the most substantial economic problems affecting all countries. It is crucial to study this phenomenon because of its direct impact on economic growth, which is one of the indices that reflect the strength, progress and prosperity of the economy in the whole world. From that perspective, this research study attempted to predict Algeria's monthly unemployment rate during January 2001-December 2020, using time-series models, i.e. SARIMA Model. The following basic points were concluded drawing on eviews programm and Modern Python Programming:

- SARIMA (5.1.3) (1.0.0) was selected as the best model for better Algeria's monthly unemployment forecasting.
- Diagnostic phase findings indicated that the suggested model was statistically acceptable. It was found that the residues follow the normal distribution, and they did not suffer from neither autocorrelation problem nor from disparity homogeneity instability issues.
- In-Sample forecast findings indicated that the selected model emulates well the original series.
- Based on the future forecast findings of 2021 monthly unemployment rates, their ratios continue to increase significantly. This increase is explained, mainly, by the Covid-19 epidemic ongoing spread, which has created enormous gap in the national economy. Consequently, the government has to find solutions that

reduce unemployment rates future severity, which align with the epidemic spread while awaiting its drastic elimination.

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