

Predictive study of electricity sales in Algeria

(January 2020-December 2025)

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Abstract ;

In this study, we will apply the Box-Jenkins methodology to the monthly series of electricity sales in Algeria over the period from January 2019 to December 2024. The Box-Jenkins forecasting methodology is one of the oldest statistical methods, requiring a large amount of data. In our case, we have 84 observations and therefore expect to obtain a high-quality forecast using Eviews 12 software for the standard processing of the series under study.

This study focuses on a series representing electricity sales in Algeria, which shows national electricity sales over the period from January 2020 to December 2025.

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1. Introduction

Algeria has recently embarked on a new experiment, moving towards a market economy and privatizing public institutions as forms of economic activity whose goal is to generate profits in order to prove their continued existence.

Economic institutions are included in these reforms so that they too can develop strategies to keep pace with global developments. Among these institutions are those involved in electricity production, which are considered to be among the most important institutions underpinning any economy.

Forecasting methods are one of the economic studies suitable for developing an accurate strategy for economic institutions for the purpose of making appropriate decisions to reduce risks and costs and maximize profits. Therefore, we had to choose one of the models represented by the Box-Jenkins methodology and apply it to electricity sales.

The benefit of this methodology is its accuracy in short-term forecasting using the data available to us, as it is considered one of the most reliable statistical methods. Based on the above, the following problem can be formulated:

1.1 Research problem:

What are the main determinants affecting electricity sales and what are their predictive values for the future?

1.2 Research questions:

What are the measures on which the Box-Jenkins methodology can be applied?

Is it possible to identify the actual determinants affecting electricity sales?

Is there a statistically significant effect on the predictive values of electricity sales?

1.3 Research Hypotheses:

There are measures by which the Box-Jenkins methodology can be applied.

The Box-Jenkins methodology is the appropriate model for this study.

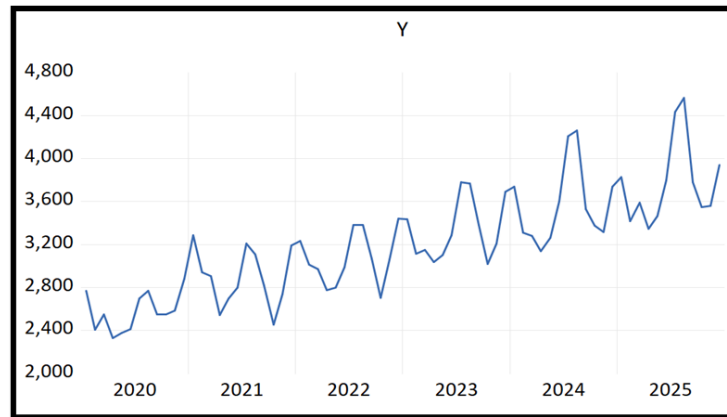
There is a short-term relationship between determinants and electricity sales.

2. Analytical study :

2.1 Graphical Analysis :

Before performing any analysis of the time series, it is necessary to carefully study the graph representing the evolution of electricity sales, as this will give us a general idea of the nature and characteristics of the specific path of the series, including: the general trend, the seasonal component, and the random component

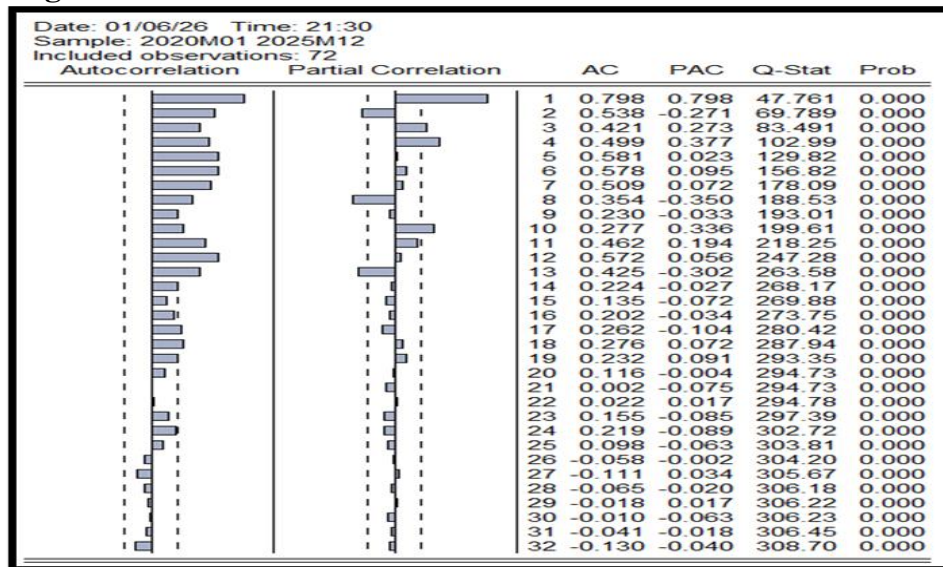
Fig.1. Historical development of electricity sales in Algeria



Source: Prepared by the researcher based on the outputs of the eviews program

The curve represents changes in electricity sales in Algeria, where we observe an increase in electricity sales over the years due to population growth and industrial development. In 2020, the value was 2,800, and the highest value in 2025 was 4,500. We also observe repeated fluctuations of the same value every year, suggesting the existence of a seasonal component. The increase in the curve over the years suggests a general trend and, therefore, instability in the series

Fig.2. Correlogram series Y



Source: Prepared by the researcher based on the outputs of the eviews program

We note in the graph of the simple autocorrelation function above that the values of the autocorrelation function r_h lie outside the confidence interval, meaning that they have a statistical significance different from zero. This suggests the presence of a general trend component within the series, and therefore we consider the series to be unstable.

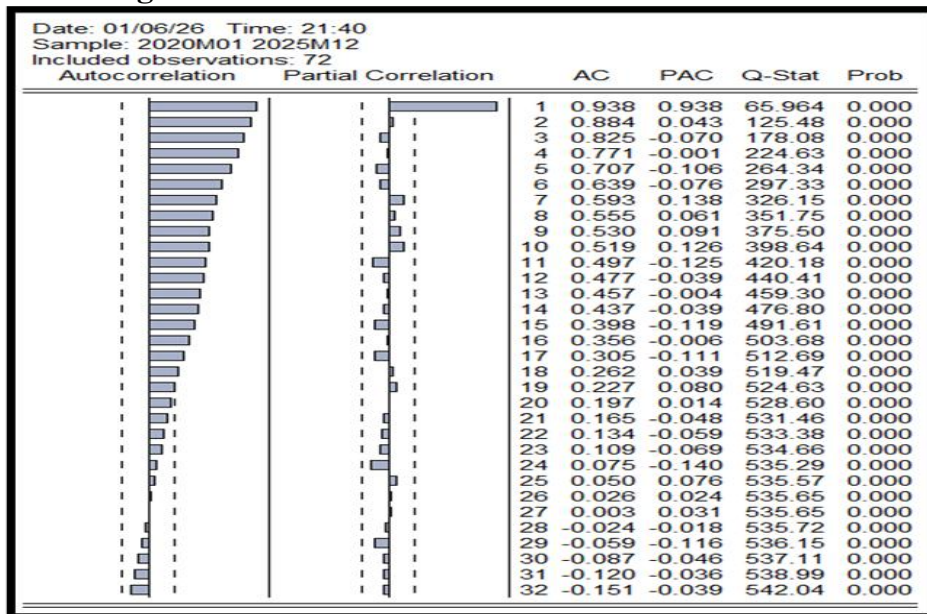
Fig.3. Graphical representation after removal of the seasonal components



Source: Prepared by the researcher based on the outputs of the eviews program

The curve above represents the graphical representation of the seasonal component-removed series (Ysa). We note the presence of the general trend component and, consequently, the instability of the series (Ysa).

Fig.4. correlation diagram series Ysa



Source: Prepared by the researcher based on the outputs of the eviews program

We observe from Figure 4 (Correlogramme serie Ysa) that the values of the autocorrelation function lie outside the confidence interval, meaning that they are statistically significant but decrease as the lag values increase. This shows us that there is a general trend component within the Ysa series, and we therefore conclude that the series is unstable.

3. stability study :

To study stability, we use the Dickey-Fuller test

Table 1. Dickey-Fuller test results

Dickey-Fuller test			Type of test
(1) ΔY (4)	(2) ΔY (5)	(3) ΔY (6)	Model
0.9645 (1.478153)	0.5977 (-1.358312)	0.0000 (-5.862691)	Ysa
0.0000 (-10.42029)	0.0001 (-10.68753)	0.0000 (-10.64342)	D(Ysa)

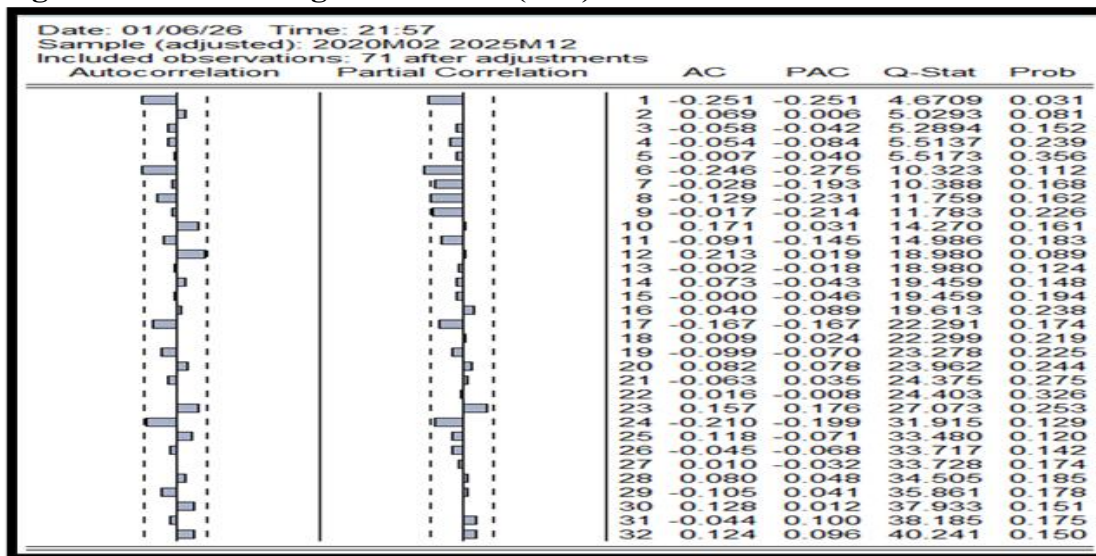
Source: Prepared by the researcher based on the outputs of the eviews program

Looking at the table above, YSA has a unit root in model type (5) and model (4), but it does not have a unit root in model (6). Therefore, YSA is unstable according to Dickey and Fuller.

As for D(YSA), it is free of unit roots in model types (4), (5), and (6) and is therefore stable of the first order, and its integration order is 1 $Y \rightarrow I(1)$

3.1. Determining and selecting the best model for the series (D(Ysa):

Fig.5. correlation diagram series D(Ysa)



Source: Prepared by the researcher based on the outputs of the eviews program

Figure 5 proposes a set of possible models for the stable DYSA series and identifies the most important ARMA(p,q) models, which are written as follows:

$$DY_t = a_0 + a_1 DY_{t-1} + a_2 DY_{t-2} + \dots + a_p DY_{t-p} + b_1 \varepsilon_{t-1} + b_2 \varepsilon_{t-2} + \dots + b_q \varepsilon_{t-q} + \varepsilon_t$$

To determine the values of p and q , we use the correlogram series $D(Y_{sa})$, where by analyzing this graph of the simple and partial autocorrelation functions of the DYSA series, we can propose the following models:

AR(1), AR(6), MA(1), MA(6), ARMA(1;1), ARMA(1;6), ARMA(6;1), ARMA(6;6)

Table 2. Results of the comparison between the models

significance	LOG	H.Q	SCH.	AIC	Forms
Nonsignificance	-432.9264	12.31764	12.37522	12.27962	AR(1)
significance	-432.5455	12.30691	12.36449	12.26889	AR(6)
Nonsignificance	-432.9965	12.31961	12.37720	12.28159	MA(1)
Nonsignificance	-433.3960	12.33087	12.38845	12.29285	MA(6)
Nonsignificance	-427.5641	12.20743	12.28421	12.15674	ARMA(1;1)
significance	-430.2020	12.28173	12.35852	12.23104	ARMA(1;6)
significance	-427.9864	12.21932	12.29611	12.16863	ARMA(6;1)
Nonsignificance	-431.9241	12.33024	12.40703	12.27955	ARMA(6;6)

Source: Prepared by the researcher based on the outputs of the eviews program

The proposed table summarizes the quality criteria for the aforementioned proposed models in terms of quality and statistical acceptability. We therefore seek the optimal model for the stable series DYSA, based on the previously nominated models and relying on several criteria, including: Akaike, SchawrzHannan-Quinn, and Log likelihood. The optimal model is the one that shows us the best fit between these criteria. For the models, we can choose the ARMA(6;1) model, because it has the lowest value in the Akaike criterion (12.16863).

4. Model validity study:

To examine the validity of the ARMA(6;1) model, we must test the individual significance of the parameters and the overall significance of the model.

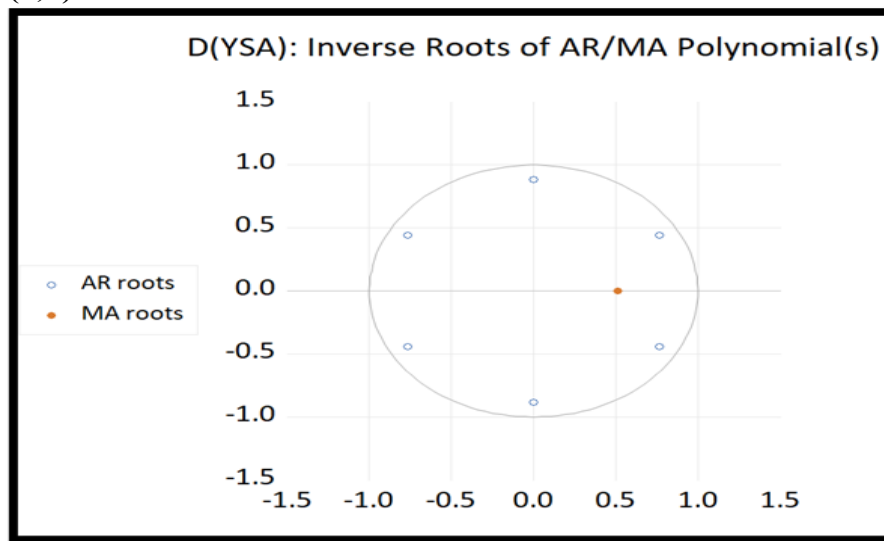
For the individual significance of the model parameters, we use the Stodt test, which is acceptable at a significance level of 1%.

As for the overall significance of the model, it is acceptable at the 1% level, meaning that the model as a whole is significant.

4.1. Study of stability and reversibility of the optimal model

The estimation results indicate that ARMA(6;1) is reversible because its accompanying polynomial root lies within the unit circle and its table is less than one. Therefore, we can say that the model under study, ARMA(6;1), is a stable and reversible model.

Fig.6. ARMA(6,1) model

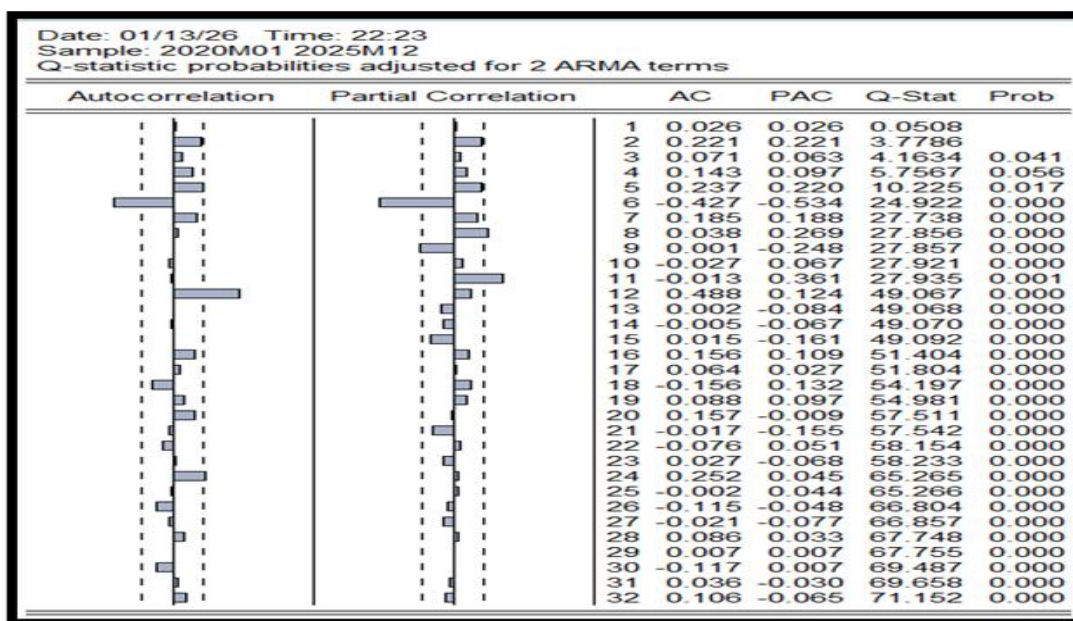


Source: Prepared by the researcher based on the outputs of the eviews program

4.2. Study of the autocorrelation of residuals:

The autocorrelation function of the residuals indicates that the autocorrelation coefficients calculated for gaps $h=28$ are all statistically insignificant. This result is confirmed by the Ljung-Box test, and the statistic calculated for this test agrees with the last value in the Q-Stat column. Through the probability associated with this statistic, we can accept the null hypothesis at a significance level of 10% and thus conclude that there is no autocorrelation within the model residuals.

Fig.7. Autocorrelation function of residuals

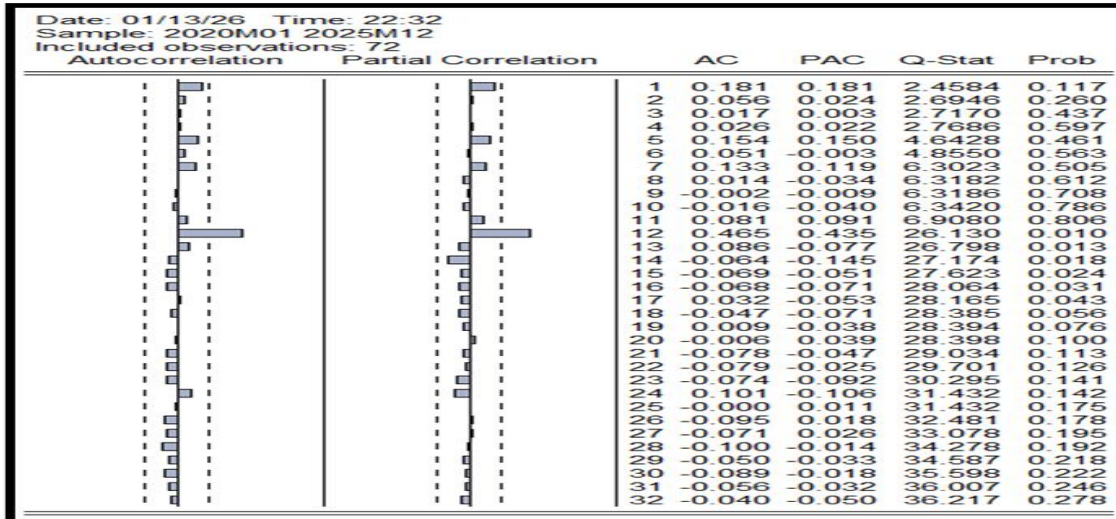


Source: Prepared by the researcher based on the outputs of the eviews program

4.3. Study of residual variance stability:

The analysis of the simple and partial autocorrelation coefficients of the residual squares shown in Figure 8 confirms that they are statistically insignificant (The probability associated with the Ljung-Box test statistic confirms the acceptance of the null hypothesis at a significance level of 10%. Therefore, the variance of the residuals is constant throughout the study period.

Fig.8. Variance stability function for residuals



Source: Prepared by the researcher based on the outputs of the eviews program

4.4. ARCH test:

Fig.9. ARCH test

Heteroskedasticity Test: ARCH				
F-statistic	0.790978	Prob. F(3,65)	0.5033	
Obs*R-squared	2.430241	Prob. Chi-Square(3)	0.4880	
Test Equation:				
Dependent Variable: RESID^2				
Method: Least Squares				
Date: 01/13/26 Time: 22:35				
Sample (adjusted): 2020M04 2025M12				
Included observations: 69 after adjustments				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	55833.84	18805.66	2.968992	0.0042
RESID^2(-1)	0.183055	0.124648	1.468581	0.1468
RESID^2(-2)	0.020890	0.126578	0.165037	0.8694
RESID^2(-3)	0.003679	0.124563	0.029538	0.9765
R-squared	0.035221	Mean dependent var		70086.27
Adjusted R-squared	-0.009307	S.D. dependent var		112397.4
S.E. of regression	112919.2	Akaike info criterion		26.16296
Sum squared resid	8.29E+11	Schwarz criterion		26.29247
Log likelihood	-898.6220	Hannan-Quinn criter.		26.21434
F-statistic	0.790978	Durbin-Watson stat		1.934091
Prob(F-statistic)	0.503311			

Source: Prepared by the researcher based on the outputs of the eviews program

$$e_t^2 = \alpha_0 + \alpha_1 e_{t-1}^2 + \alpha_2 e_{t-2}^2 + \alpha_3 e_{t-3}^2 + u_t$$

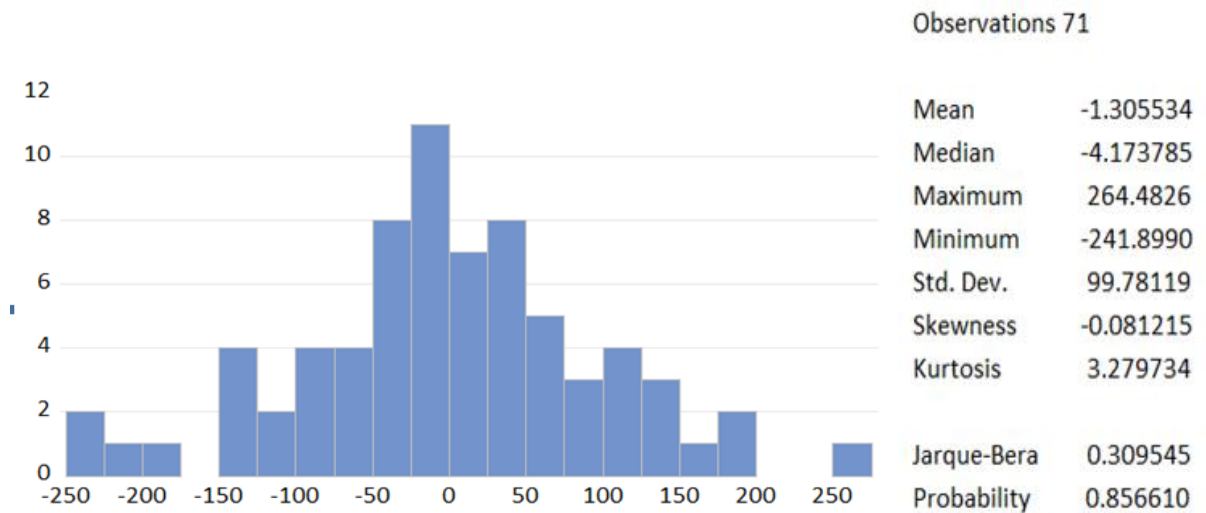
The Student's t-test shows us that the parameters and constants are statistically and semantically unacceptable at the 1% level, and therefore:

$$e_t^2 = u_t$$

The probability associated with this test is equal to (0.36), and therefore we accept the null hypothesis at 10% and say that the stability of the residual variance during the study period has been achieved. Also, based on the previous results, it means that it is a white noise series.

4.5. Normal distribution test:

Fig.10. Normal distribution test



Source: Prepared by the researcher based on the outputs of the eviews program

Our symmetry and torsion coefficients are: $\beta_1^{1/2} = \frac{\mu_3}{\mu_2^{3/2}}$

It follows the condition of normal distribution: $\beta_1^{1/2} \rightarrow N(0, 6/n)$

Therefore, the statistics for symmetry and torsion are:

$$V_1 = \frac{|\beta_1^{1/2} - 0|}{\sqrt{6/n}} = \frac{|-0.081215 - 0|}{\sqrt{6/71}} = 0.27$$

We have: $V_1 = 0.27 < 1.96$

Therefore, we can accept the null hypothesis, i.e., the residuals are symmetrical at a significance level of 5%.

- Our kurtosis coefficient is: $\beta_2 = \frac{\mu_4}{\mu_2^2}$

It is subject to normal distribution: $\beta_2 \rightarrow N(3, 24/n)$

Therefore, the statistical probability is:

$$V_2 = \frac{|\beta_2 - 3|}{\sqrt{24/n}} = \frac{|3.27973 - 3|}{\sqrt{24/71}} = 0.48113$$

We have: $V_2 = 0.48113 < 1.96$

Therefore, we can accept the null hypothesis and the residual series is flat at a significance level of 5%. In conclusion, we can say that the residual series is symmetrical and flat, and therefore follows a normal distribution.

4.6. Test (Jareque Bera, 1984):

The statistic calculated for this test is as follows:

$$S = \frac{n}{6} \beta_1 + \frac{n}{24} (\beta_2 - 3)^2 \rightarrow \chi^2(2)$$
$$S = \frac{n}{6} \beta_1 + \frac{n}{24} (\beta_2 - 3)^2 = V_1^2 + V_2^2 = 0.27^2 + 0.48^2 = 0.3033$$

At our level of significance 5 % :

$$S = 0.3033 < \chi_{0.05}^2(2) = 5.991$$

so, we accept the null hypothesis, i.e., that the residual series is normally distributed.

4.7. Evaluation summary:

Based on the results obtained, the ARMA(6;1) model is statistically acceptable using Student's t-test and Fisher's test, and we can say that it is stable. Furthermore, the model residuals are not autocorrelated and are characterized by constant variance, which means that they are a white noise series and are normally distributed. Therefore, the proposed model is acceptable, and we can continue the study to make predictions for six future observations.

5. Prediction:

The Box-Jenkins methodology is based on a systematic study of time series based on their characteristics, in order to classify them within the ARMA family of models and identify the model best suited to the phenomenon under study. The forecast aims to use the estimated and appropriate model to estimate future values as a time series. Since the forecast error is a random variable, we minimize the expected values.

5.1. Prediction results:

Table 3. Predictive values

January 2026	February 2026	March 2026	April 2026	May 2026	June 2026
4006.303	4025.435	4044.577	4063.713	4082.849	4101.982

Source: Prepared by the researcher based on the outputs of the eviews program

6. Summary:

The importance of electrical energy is clear to consumers, as it is one of the essential and vital pillars of development, in addition to providing goods and services that citizens need in their daily lives.

Electricity is a fundamental and indispensable element of the environment, and therefore energy must be conserved and developed to meet growing demand, as well as to increase sales and raise per capita energy consumption.

The study included an analysis of the monthly series of electricity sales in Algeria. On the descriptive side, we noticed that the series and its development rate contain a seasonal component, which required removing this component and building a stable model.

After selecting the stable ARMA (6;1) model, estimating it, and verifying its validity, the predictive values over a period of six months showed consistency with the general trend of the series under study.

7. Marginal notes and references:

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