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An econometric study on the factors effecting household electricity consumption (city of chelef from 2004-2019)

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ABSTRACT

Household final consumption occupies an important place in Algeria; it is designated as the sole and ultimate objective of all production. In Algeria energy consumption continues to grow at the rate of 5% every year and this is due mainly to the improvement in the standard ofliving.

This importance of household consumption inspired one to analyze the household consumption in the city of chelef in terms of some variables which are: the price of electricity,metrological data , economic activity, sociological determinants…….

One has done an empirical study for the impact of the independent variables on household electricity consumption in the city of chelef from 2004 to 2019. For this purpose one has estimated a model with two variables by using the OLS method. This estimation allowed detecting the relationship and the influence of each variable on household electricity consumption in the city of chelef.

الملخص

يحتل الاستهلاك المنزلي النهائي للكهرباء مكانة مهمة في الجزائر؛ حيث يعتبر عنصر اساسي في عملية الإنتاج. كما تشهد الجزائرا نموا متزايدا قدر بمعدل 5٪ في العام في الاستهلاك المنزلي للكهرباء الذي يرجع أساسًا إلى تحسن مستوى المعيشة.

حيث قمنا في دراستنا هده بمحاولة معرفة العوامل المؤثرة في للاستهلاك المنزلي بدراسة حالة ولاية الشلف من خلال بعض المتغيرات وهي: سعر الكهرباء ، بيانات الطقس ، والنشاط الاقتصادي ، والمحددات الاجتماعية .....

و جائت هده الدراسة لدراسة تأثير المتغيرات المستقلة المذكورة سالفا على استهلاك الكهرباء المنزلية في مدينة الشلف من عام 2004 إلى عام 2019. ولهذا الغرض ، استعملنا نموذجًا بمتغيرين باستخدام طريقة OLS. أتاح هذا التقدير الكشف عن علاقة وتأثير كل متغير على استهلاك الكهرباء المنزلية في مدينة الشلف.

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1. Introduction

In recent years, the demand for electricity in Algeria has undergone significant changes, reaching significant consumption peaks. This sharp increase in demand is a direct consequence of the change in consumer habits and the improvement of their quality of life and the demographic growth, as well as the importance given to the economic and industrial sector. Over the years, the use of electricity has become intense since it is necessary for all human activities and essential for satisfying basic social needs.

And from this, the problematic will be articulated around the following main question:**what are the factors effecting household electricity consumption ?**

2. Definition of Consumption

"Consumption, in the economic sense of the term, is the action of using or destroying, immediately or gradually, goods and services (a loaf, a mobile phone) in order to satisfy a need. Consumption designates in the first place the purchase but it is also a set of uses of goods, social interactions around this act of purchase, generally with the aim of satisfying needs or desires. It is the work of consumers, businesses and the State. It also depends on the uses of social groups, the constraints of collective life, the social construction of the market, and the effects of globalization" (Mapendo nyambwe, 2010, p19).

INSEE, 2016 (the French institute of statistics and economic studies) defines consumption as follows: "Final consumption represents the value of goods and services used for the direct satisfaction of human needs whether individual (final household consumption) or collective (final consumption of non-market services by public administrations and private)" (INSEE, 2016).

Thierry affirms that Consumption is considered to be a relationship that exists between the desired value of consumer spending and the variables that determine it. It seeks to translate the behavior of economic agents.

3. How to Measure Consumption

"The real-time measurement of consumption is carried out "indirectly": consumption is equal to the sum of production from power plants to which the balance of exports on interconnection lines is subtracted. The productions as the transits on the interconnection linesare continuously measured by sensors, while the consumption is mainly known by meter reading. Consumption (including losses) = Production + Imports-Exports" (Salmi & Rabhi., 2017, p10)

4. Household Electricity Consumption in Algeria

Electricity plays an important role in the energy supply of different sectors of the economyfor their daily activities. The industrial, commercial and residential sectors consume electricity to meet their various energy needs.

Electricity has become the mainstay of the activities carried out by Algerians. Its use has intensified overnight thanks to the services and the daily facilities it provides.

According to (Dahmani, 2016, p30) "household in Algeria are large consumers of electricity, their consumption is mainly due to household lighting, the use of audiovisual equipment and appliances as well as air conditioners in addition to public lighting. In 2000, the consumption of this energy was estimated at 3,308 GWh, which seemed exaggerated at the time".

(Bellara, 2005, p13) "The needs of household reside in the amount of energy necessary to meet their needs and maintain a suitable indoor climate. During the period 1996 to 2006, the consumption of domestic electricity compared to national consumption rose from 19.2% to 30.17%, the causes of this increase appear in the surface expansion and the cost of electricity which is cheaper".

(Ferhat , 2016) mentioned in his online article that APRUE stated that Algerian household consume almost ten times more electricity by i

nternational standards and twice as much as theaverage for Maghreb countries.

(D.Akila, 2018) added on the online journal of EL MOUDJAHID that "Algeria's energy balance statistics reveal that one country ranks among those who consume the most electric energy. A trend that concerns, first of all, household, up to 40%, followed by industry with less than 30%. The indicators show that the consumption of Algerian households increased by6% between 2016 and 2017, without modification of the structure of consumption classes, remaining constant over the two years 2015 and 2017".

The same source went to add that "annual household consumption alone represents the equivalent production of a 493 MW power plant operating at full load 24 hours a day, consuming 1.07 billion Normal Meter Cube of natural gas. Maximum Power demand (maximum quarter-hour power "PMA") recorded in a year on the national interconnected network, has gone from 4,617 MW in 2000 to 14,181 MW in 2017, i.e. an average annual change of 6.91%" (D.Akila, 2018).

Table 1: The National Household Electricity Consumption (2000-2018).

YEAR	Household Electricity Consumption (GWh).		
	Residential.	Agriculture.	Tertiary and Others.
2000	3308		
2008	19920		
2009	20148		
2010	11757	1005	7374
2011	12915	1098	8020
2012	14764	1245	9024
2013	17181	727	8784
2014	17579	1397	9888
2015	19672	1375	10691
2016	20210	1419	11071
2017	21776	1521	11829
2018	24726	1204	10381

Household consumption has increased sharply, particularly in recent years. The final consumption of an Algerian household from 2000 to 2012 has more than doubled and has passed from 3308 GW to 14764 GW in 2012, it continued its increase with an accelerated rate(continuous increase) it reached 24726 GW in 2018. This increase can be due to the lower price of this type of energy or to the fact that the population is also increasing sharply, in 2000it was 31 183 660 inhabitant and in 2018 it was 42 101 125

In 2019 household electric power consumption reached a new record at 15,004 MW according to data from the operator of the national electric system (OS), a subsidiary of the Sonelgaz group. The peak represents an increase of 10% compared to 2018, this record came following the very high temperatures felt throughout the country, which led to a strong use of air conditioning.

5. Factors Influencing Household Electricity Consumption

Algerian society has undergone profound changes, the search for comfort associated with the desire to live a modern life has caused the demand for electricity to be excessive.

5.1. *Price*

(Mukamba Kyalondawa, 2008, p13) stated in his work for Guma university that "the price mechanism plays a fundamental role in adjusting supply and demand, to the extent that it exists. In market economies, a price level is that which establishes for any product a balance between production and consumption. This equilibrium price is a compromise between what producers can afford to charge and what consumers are willing to pay, generally the higher the price of a good, the less the demand for it from households or business will be strong and vice versa".

"The price of a consumer good on the market influences the consumer choice on a product. Consumer choice is generally focused on products with a low price" (Musimbi Mushuba, 2009, p12).

In an effort to save energy and to facilitate access to electricity for the entire population, the Algerian government has implemented progressive pricing. Thus the first 125 KWh consumed turns out to be at an affordable price of 177.9 cDA / KWh pre-tax, while the following KWh are billed from 417.9 cDA / kWh to 547.96 cDA/ KWh pre-tax. This volume of price caused an irrational behavior of the costumer and an over demand of electricity. Therefore having a good policy when it comes to electricity prices could encourage customersto use electric energy in moderation. Even with additional annual global demand for electricity, consumers will adopt more rational behavior which could offset overconsumption.

5.2.Metrology

(Salmi & Rabhi, 2017, p08) both stated that "metrological data are the first elements influencing the consumption of electricity. The evolution of weather conditions throughout the year is largely responsible for the annual cyclical variations in consumption".

To establish a forecast, each producing electricity company must imperatively use in particular two quantities, provided by the Weather:

5.2.1. Temperature: **"**measured by sensors. These variations translate into changes in the use of electric heating or air conditioning in summer" (Salmi & Rabhi, 2017, p09). The analysis of the urban fabric of the city of chelef which is the center of this study shows that the city has a hot and dry climate which gives the impression that one is in a city in the Sahara and that leads to a feeling of discomfort, therefore the excessive use of electricity is mainly due to the use of air conditioning.

5.2.2.Cloudiness: "(used by countries with generally cloudy skies). Cloudiness represents the cloud cover rate. This size is expressed in octa and varies from 0 to 8 (0 corresponds toa completely clear sky and 8 to an overcast sky). The cloudiness comes from a human observation of the sky. The cloudiness has an influence on the use of lighting, but also on the heating" (Salmi & Rabhi, 2017, p09).

5.3. Economic Activity

The economic activity of companies plays a major role and a strong influence on the consumption of the company, hence the companies generally have a low consumption during the summer holidays and a also weekly (lower consumption on weekends) (Salmi & Rabhi, 2017).

5.4.Legal Timetable

"This quantity is specific to the countries which use this type of time change (summer or winter timetable), also influences the consumption of electricity by shifting the day compared to solar time. The summer timetable has practically eliminated the peak evening consumption.The maximum daily consumption is then reached in the morning, between 9 a.m. and 1 p.m.In winter, on the contrary, the peak consumption occurs at 7:00 p.m. This lasting change in the form of consumption is called a break" (Salmi & Rabhi, 2017, p09).

5.5.Special Events

Some exceptional events can disrupt the consumption profile. Here are some examples:

5.5.1The World Cup causes an increase in electricity consumption, a lot of household use thetelevision and other devices excessively to watch matches.

5.5.2Ramadan effect: During each year, the month of Ramadan is characterized by a change in consumption behavior. For example, in the past years Ramadan has come in the summer periods where the level of temperature is very high so the consumption augmented due to the use of air conditioning.

5.6.Sociological Determinants

The behavior of individuals has a significant impact on the environment. The actions of an individual or the decisions that one makes on what products to use, which lifestyle to choose creates a direct and an indirect impact to his consumption.

Many sociological factors can be decisive in the consumption process.

5.6.1.Social class: The consumption of an individual varies according to his habits which he acquired through his education. The reproduction of the lifestyle of the original social class therefore influences consumption.

5.6.2.Age: An elderly individual, for example, consumes less than an adolescent.

5.6.3.The lifestyle: Consumption is partly influenced by the lifestyle of the individual, for example, an individual who lives in an apartment consumes less than an individual who lives in a large house.

6. An Econometric Study on the Determinants of Household Electricity Consumption in the City of chelef (2004Q1- 2019Q4): Application on Eviews.

One chose the econometric study because econometrics science is currently one of the most active branches of economic research. In addition, it is an essential tool to identify relationships between different variables invalidated or validated theories and even anticipatesthe future of economic research by revealing new problems that require appropriate conceptual developments.

"Econometrics is a quantitative analysis tool, making it possible to verify the existence of certain relationships between economic phenomena and to measure these relationships concretely on the basis of observations of real facts" (Dor,2004, p31).

6.1. Specification of the Model

In this study one wants to know the impact of the medium price of electricity (MP) and the number of clients (NC) on household electricity consumption (Y) in the city of chelef from 2004Q1 to 2019Q4. One has two independent variables to explain the dependent variable that is the household electricity consumption, hence one model is a multiple regression with two variables and it is written as:

$yt = a0 + a1\ x1t + a2\ x2t + \varepsilon t.$

ε = is an error term.

6.2. Presentation of Data and Choice of Variables

One is trying to explain whether the medium price of electricity and the number of clients registered in SONELGAZ has an influence on the excessive household electricity consumption in the city of Chelef.

One will use the quarterly chronological data (time series) going from 2004Q1 to 2019Q4.One used the quarter data because there was not enough annual data to do a study on Eviews. T = 64 (t> 15 from which one can perform several tests) and the number of explanatory variables is: k = 2

Table 2: variables and ther sources

Variables	**Source**
Household electricity consumption (Y).	SONELGAZ chelef
Number of clients (NC).	SONELGAZ chelef .
Medium price of electricity (MP).	SONELGAZ chelef .

The variables chosen for this Variable explained (dependent):

- Household electricity consumption of the city of Chelef (KWh).

Explanatory variables (independent variables):

- Number of clients registered in SONELGAZ Chelef.
- The electricity's medium price (cDA).

6.2.1. A Graphical Study on the Series of Household Electricity Consumption in the city of chelef (2004Q1-2019Q4).

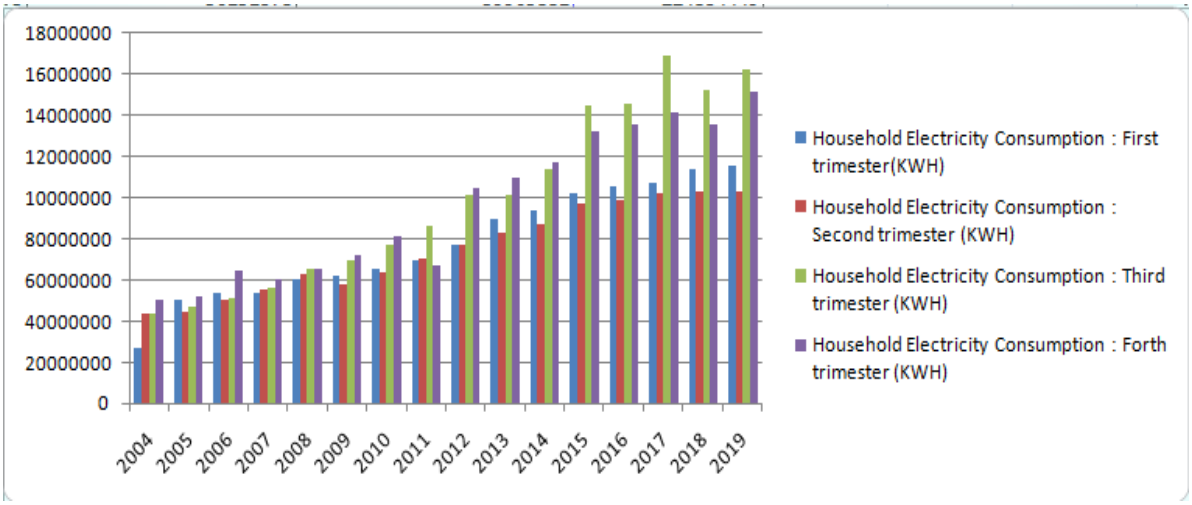

Figure1 : The evolution of household electricity consumptionin the city of chelef trimester (2004-2019).

6.2.2. A Graphical Study on the Series of the Number of Clients Registered in Sonelgaz chelef (2004Q1 – 2019Q4).

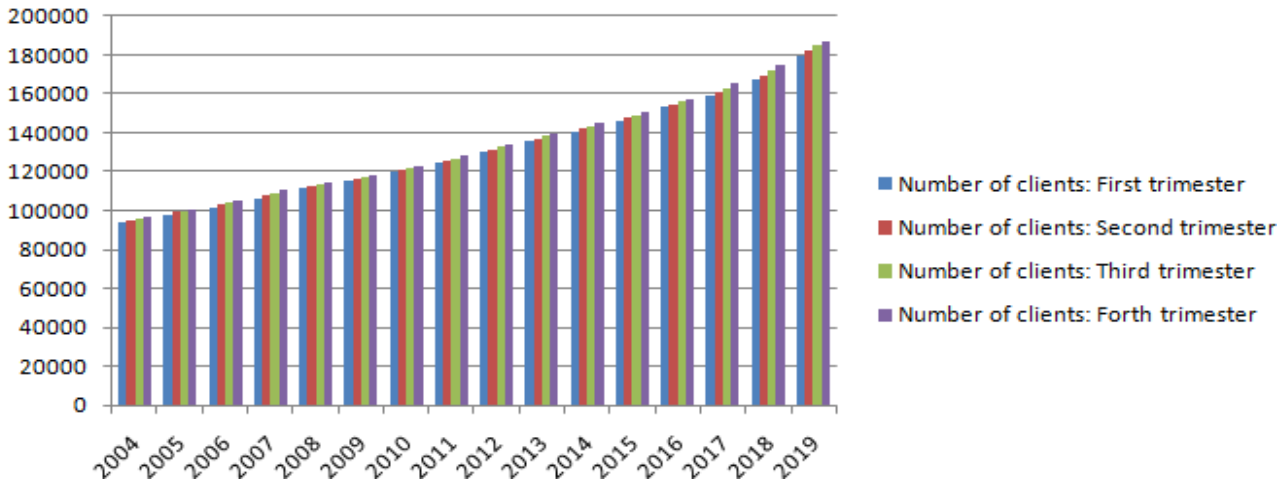

Figure 2: The Evolution of the Number of Clients of SONELGAZ in the City of chelef Trimester (2004Q1-2019Q4).

6.2.3. A Graphical Study on the Series of the Medium Price of Electricity (2004Q1 –2019Q4).

Figure2: The Evolution of the Medium Price of electricity per trimester (2004-2019)

So one's model is:

$Y_t = C + a_1\ NC_{1t} + a_2\ MP_{2t} + \varepsilon t.$

In order to do the study on Eviews one used the logarithm on the variables to have a log model and thus be able to easily interpret the estimated coefficients. In the model without logarithm the coefficients were extremely big (the log level makes it possible to decrease the volume of the numbers representing a series).

The new model is:

$LY_t = C + a_1\ LNC_{1t} + a_2\ LMP_{2t} + \varepsilon t.$

7. Regression on Eviews and Analysis of Results

One will use the ordinary least squares (OLS) method which consists in minimizing thesum of the squares of the errors on the Eviews software, which leads to the following results:

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Dependent Variable: LY
Method: Least Squares
Date: 05/09/20 Time: 13:10
Sample: 2004Q1 2019Q4
Included observations: 64

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-5.231630	1.324857	-3.948825	0.0002
LNC	1.702931	0.177603	9.588415	0.0000
LMP	0.562499	0.415537	1.353666	0.1808

R-squared	0.871384	Mean dependent var	18.20556
Adjusted R-squared	0.867167	S.D. dependent var	0.398858
S.E. of regression	0.145369	Akaike info criterion	-0.973348
Sum squared resid	1.289054	Schwarz criterion	-0.872150
Log likelihood	34.14713	Hannan-Quinn criter.	-0.933481
F-statistic	206.6401	Durbin-Watson stat	1.550537
Prob(F-statistic)	0.000000		

Figure 4: Multiple Linear Regressions by the OLS Method on Eviews.

According to the table above one's model is:

LY = -5.231630018 + 1.70293078487*LNC + 0.562498520975*LMP.

7.1 Significance of the Model and the Explanatory Variables

One has:

H_0 : Xt is not significant .

H_1 : Xt is significant.

For P= 0.05.

- For the Fisher test one has the probability (F-statistic = 0.000) lower than the 5% , sothe model is entirely significant.
- One has R squared (R2) = 0.8713 which means that the explanatory variables explain 87. 13 % of the variation of the explained variable so one's model is good so far. Just12% is explained by other variables.
- The probability of LNC is less than 0.05 (P= 0.0000) therefore one rejects H_0 and accepts that the coefficient of the explanatory variable LNC is significantly different from 0 and LNC contributes to the explanation of the dependent variable (LY).
- Since the probability of the explanatory variable LMP (p = 0.1808) is greater than 0.05one accepts H_0. The coefficient of this variable is not significantly different from 0 andthe variable LMP is not significant therefore it does not contribute in the explanation of the dependent variable LY (household electricity consumption), one can explain this non-significance by the non-rationality of consumers of the city of chelef and that the relative increase in the price of electricity does not change the irrational behavior of household in the city of chelef .
- Since the probability of the constant (p = 0) is less than 0.05 (p= 0.0002), then one accepts H_1 the coefficient of the constant is significantly different from 0 and the constant is significant. So the model is linear.

7.2 Test of Multicolinearity

"Multicolinearity indicates a high correlation between the independent variables of a multiple linear regression model. The explanatory series are linked together" (Mister Tcham lessons, Multicolinéarité et selection des variables).

One of the basic hypotheses of the multiple linear regression model is that the matrix X is of full rank → Rank (X) = k + 1. This hypothesis means that the explanatory variablesare linearly independent.

When such a hypothesis is lifted (violated), the explanatory variables are linked which means there is Multicolinearity.

7.2.1 . Klien's Test

Klein's test is based on the comparison of the coefficient of determination R^2y calculated on the k variable model:

$Y = â0 + â1x1 + â2x2$ ……$+ âkxk + e.$

And the simple correlation coefficients r^2xi,xj between the explanatory variables for i = j.If $R^2y < r^2xi,xj$, there is a presumption of Multicolinearity.

It is not a statistical test in the sense of hypothesis testing but simply a criterion of presumption of Multicolinearity.

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Correlation

	LMP	LNC		
LMP	1.000000	0.848420		
LNC	0.848420	1.000000		

Figure 5: Correlation Matrix

According to the correlation table, it turns out that there is no correlation between the variables LNC, LMP, (number of clients and the medium price of electricity).

$r^2x1x2 = 0.8484 < R2 = 0.8713.$

7.3 Test of Autocorrelation

Serial correlation: correlation between errors relating to different time periods, in a time series or panel data model (errors are linked).

One can detect the correlation between errors by performing the test of Breusch- Godfrey or the test of Durbin Watson. The Breusch-Godfrey test makes it possible to detect autocorrelation of any order. The Durbin Watson test allows detecting the autocorrelation only of the first order.

7.3.1. Breusch-Godfrey Serial Correlation LM Test

One will verify the model by performing the breusch- godfrey test:$H0$: residues are not autocorrelated. One accepts if p> 0.05.

$H1$: residues are autocorrelated.

Figure 6: Breusch-Godfrey Serial Correlation LM Test

View | Proc | Object | Print | Name | Freeze | Estimate | Forecast | Stats | Resids

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	2.920417	Prob. F(2,59)	0.0617
Obs*R-squared	5.765092	Prob. Chi-Square(2)	0.0560

In this model, the probability is p= 0.0560 > 0.05 therefore one accepts the null hypothesis H0, the residues are note autocorrelated, this means that the error relating to year T has no influence on the errors of the following years.

7.4 Test of Heteroscedasticity

When the variance of the error term is not constant, varies over time or varies with the observation of one or more explanatory variables then there is presence of Heteroscedasticity.

7.4.1 . WHITE's Test

It has the advantage of not being based on the assumption of normality of the error term.

It consists in testing the null hypothesis of homoscedasticity against the alternative hypothesis of Heteroscedasticity.

One will verify the model by performing the white test:

H_0 : the residues are not heteroscedastic . One accepts H0 if $p>0.05$ H_1 : the residues are heteroscedastic if $p<0.05$

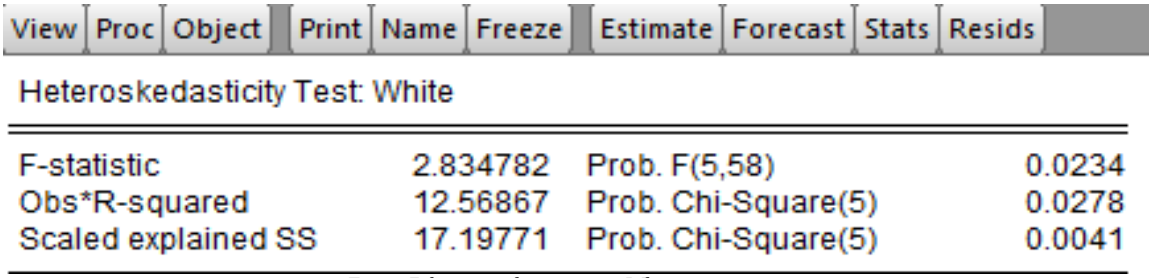

Figure 7: heteroscedasticity test: White

According to the table above the probability ($p= 0.0278$) < 0.05 therefore the modelhas a heteroscedasticity problem and the homoscedasticity hypothesis is not accepted.

7.5.Test of Normality

7.5.1. Test of Jarque-Bera

For the normality test one used the histogram of Jarque-bera:H_0: the residues are normally distributed, one accepts if $p> 0.05$.H_1: the residues are not normally distributed if $p<0.05$.

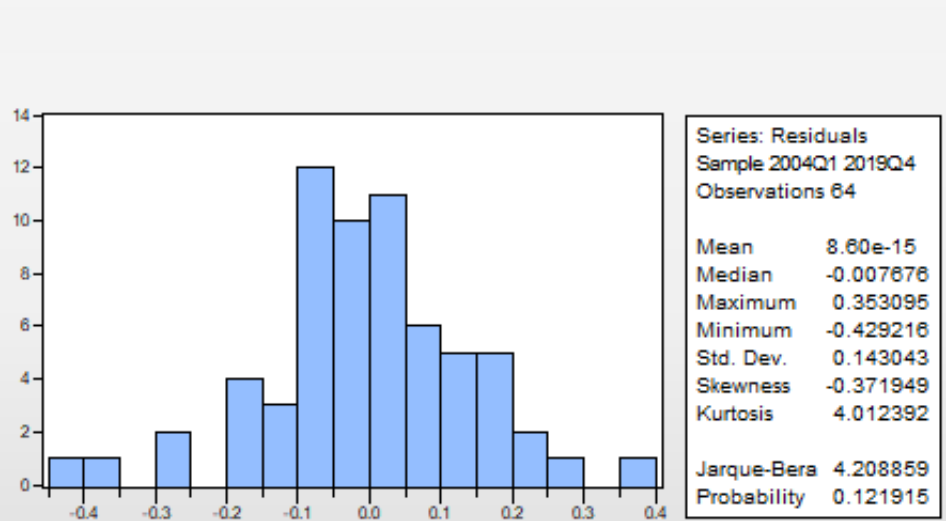

Figure 8: The Normality test: Histogram of Jarque-Bera

The probability is p= 0.1219, one accepts the H0. The residues are normallydistributed.

8. Economic Interpretation of the Results

LY = -5.231630018 + 1.70293078487*LNC + 0.562498520975*LMP

The results obtained from the empirical econometric study on the factors favoring the household electricity consumption in the city of chelef show that:

On the one hand, one' model is significant in its entirety with a high explanatory capacity of 87.13%, which justifies that the choice of the explanatory variables is good and acceptable, they make it possible to explain 87% of the variation of the model.

Regarding the significance of the variables, one found that the number of clients registeredin SONELGAZ chelef is significant which means that this variable contributes in the explanation of the household electricity consumption in the ity of chelef. The more the number of clients is higher the more the household electricity consumption is intense.

When it comes to the second variable, the medium price, one found that the price is not significant and has no influence on the household electricity consumption. Both the explanatory variables have their coefficients' sign as postulated by economic theory (positive sign).

With the significance of the constant, one therefore concluded that there is a linear relationship between the consumption of electricity and the change in the number of clients registered in SONELGAZ chelef.

Household daily activities are all based on using electricity which makes it impossible to abandon it and Sonelgaz have at least one client to consume electricity and even if there is no clients the company itself will consume. Some of the electricity consumption also goes in electrical loses. The city of chelef loses yearly 6% of electricity as a loss and that is also consumption.

On the other hand, by performing tests on Eviews, one found that there is no multicolinearity between the explanatory variables (number of clients and the medium price), which means that the explanatory variables are not correlated, the residues were not autocorrelated and were normally distributed but there was a presence of a Heteroscedasticity.

These results are compatible with reality, the number of clients affects enormously the household electricity consumption, when the price actually has no influence and people do nottake it onto consideration when it comes to their consumption. As a matter of fact, most clients do not even know the price of the KWh of electricity and that reflects the irrational behavior of the clients.

9. Conclusion

The objective of this study is to determine the impact of the number of clients and the medium price of electricity on the household electricity consumption in the city of chelef in the period of 2004 – 2019.

In theys study we analys the general linear model with two variables by multiple regressions using Eviews software, and we conclused to :

The model is entirely significant with no presences of multicolinearity between the number of clients and the medium price of electricity,

absence of autocorrelation between the errors and a presence of heteroscedasticity between the residues which explain the instability of the coefficients of the least squares which cause an increase in the estimated variance of certain coefficients. In addition,

this study helped verifying the theoretical part .

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[10] **F**rench Institute of Statistics and Economic Studies (INSEE), https://www.insee.fr/en/metadonnees/definition/c1322#:~:text=Final%20household%20consumption%20expenditure%20consists,satisfaction%20of%20needs%20or%20wants.&text=It%20also%20includes%20imputed%20rents,residence%20implicitly%20pay%20to%20themselves. Consulted on 10/03/2020.