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Investing in Energy or ICT for more Productivity in Algeria

Belghomari Wassila

Markets, Employment, Legislation and Simulation in the Maghreb laboratory, University of Belhadj Bouchaib, Ain temouchent (Algeria),
w.belghomari@yahoo.fr

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Abstract:

This study aims to analyze and highlight the impact of investment in information, communication technology and energy on the total productivity of the industrial sector in Algeria. It is considered one of the most important elements of economic growth for governments and institutions with their various tasks. This is as a way to catch up with globalization and achieve economic integration by strengthening the connection to global communication networks, along with the access to energy sources for industry. As we have concluded a broader concept of investment in the technology sector, the energy sector through Addressing a standard study to find out the impact of each of them on productivity and comparing the results to reach a conclusion in order to come up with important recommendations on the subject.

It should therefore be noted that investment in information and communication technologies will benefit the overall productivity of the industrial sector, we recommend encouraging foreign investment in the sector field of energy, because giant and pioneering companies are able to bear the costs of this type of investment. As for internal investments, we recommend directing them towards the information and communication technologies sector, particularly encouraging emerging companies in this field.

Key Words: Productivity, energy, ICT, industry.

(JEL) Classification: L0,O4,Q5

1.Introduction:

Economic development is measured by the extent to which more production is achieved by using fewer factors, so productivity in general is sensitive to this subject. For it can show the line of development of less use for more production. The productivity of a particular sector or industry shows the possibility of savings that can be achieved in inputs in order to obtain a larger amount of outputs. A clear increase in productivity may occur in an industry, and such a rise does not occur in other industries, but the high rates that occur in some industries compensate for the lack of these rates in other industries, and the result is an increase in the rate of productivity in the entire national economy, as this rise is evident in Relatively long periods of time. It is obvious that creativity and weak technology in general pushes the rates of this productivity to the lowest.

he historical experience of the Industrial Revolution confirmed that the organization of work in the "workshop", the emergence of the steam engine, the explosive engine, and the electric machine had a decisive impact in pushing productivity upwards and bringing about growth in the economy as a whole.

Examining what determines a country's GDP is central to understanding economic development and growth. Where economists paid special attention to separating the roles of total worker productivity, and the accumulated factors of production (physical and human capital), and over time, economists' interest was directed towards measuring the impact of information and communication technology technologies on productivity, as some looked at the impact of human capital and its relationship to technology, and others searched On the financial side, in addition to the returns on investment in modern and in light of the different current investments in order to raise productivity

The features of the problem that we are dealing with appear in the following question: How can Algeria raise productivity, is it through investing in energy or in information and communication technology?

1.1. Study hypotheses:

- Energy increases the productive capacity of the industrial sector in Algeria.
-The Information and communication technology raises the productive capacity of the industrial sector in Algeria

1.2.Objectives of the study:

This study aims to:

1. The relationship between investment in energy and production capacity in the industrial sector.
2. The relationship between investment in information and communication technology and productive capacity in the industrial sector.
3. Determine the best investments in order to improve productivity.
4. Identifying and knowing the most important challenges and obstacles facing this type of economic development.

5. Propose some recommendations to ensure the best direction for investment in Algeria.

2. A theoretical approach to energy and ICT for productivity:

2.1. Productivity:

The concept of productivity in general was defined by the Organization for Cooperation and Development at the Paris Conference as "the extent of using resources according to certain standards." (OCDE, 1955)

Mark defines it as “the efficiency of using resources to achieve outputs” (Mark, 1981), while Mali defines it as “a measure of how well resources are collected in organizations and used to achieve a set of results.” (Mali, 1978)

Abdul Hakim defines it as "a measure of the economic operation of the available energies.". (ibrahim, 1990)

Production is the making of a product out of raw materials, labor, energy and the result of that making.

In a broader sense, production covers everything that societies create by adding value to a real or symbolic object. “Production is therefore not reduced to material or economics. Space – that is to say an arrangement and not the objects that fit together – constitutes a specific field of production” ((IEPF), NUMÉRO 32 - 3e TRIMESTRE 1996)

2.2. Information and communications technology:

The infrastructure and components that enable modern computing. Although there is no single, universal definition of ICT, the term is generally accepted to mean all devices, networking components, applications and systems that combined allow people and organizations (i.e., businesses, nonprofit agencies, governments and criminal enterprises) to interact in the digital world. (Pratt, 2019).

2.3.Energie and industry:

The industrial revolution only happened when the energy potential of coal could be used in the steam engine. A new kind of civilization was born, founded on a new form exploitation of the energy applied to a mechanism driven by the engine. Some time for the machine to steam is the main source of energy in industry and transport, and no less than half a century to obtain equipment sufficiently reliable. Other changes were to take place, stimulated by the anticipated economic benefits.

During this period of transition, the invention and innovation have enabled the development of new materials that can withstand the pressure and the temperature of the steam engines, the elaboration accuracy standards for mechanical use machine parts, the creation of new organizational concepts for series production parts outside their place of assembly, and the accelerated vocational training for craftsmen.

The appearance of this new source of energy in the manufacturing process was accompanied by the introduction of steam engines in the modern means of transport. Thanks to the development of this transport capacity, the location of new industries could be dissociated from the place of origin of the raw materials and be chosen by investors from other economics of production.

Subsequently, scientific knowledge of electricity led to the development of electrical engineering, thus giving new impetus to the industrial revolution. Service development electricity was organized in parallel in production, transport, distribution, and end use in many types of devices.

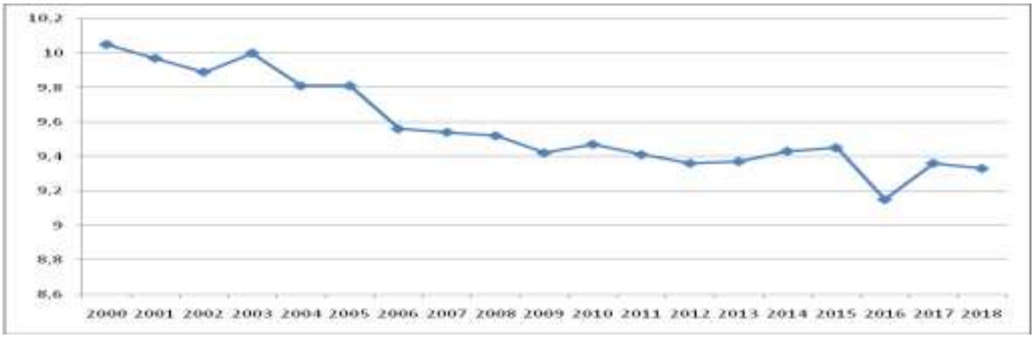
Some have introduced the electrical system as the first high complexity system designed and organized by man's hand. Considering that assembly line manufacturing began with the production of motor vehicles and thanks to the availability of a another source of energy, that of hydrocarbons liquids, it can be concluded that the energy has been closely associated with the main developments production and industrial organization. (Fossil Fuels)

3. Analysis of the study variables:

3.1. Definition of energy indicator:

This category measures the availability, sustainability and efficiency of energy sources. For this reason, it consists of energy use and access, losses in distribution, the renewable nature of energy components and sources, including the gross domestic product generated by each unit of oil to further emphasize the importance of optimal energy systems (ONU).

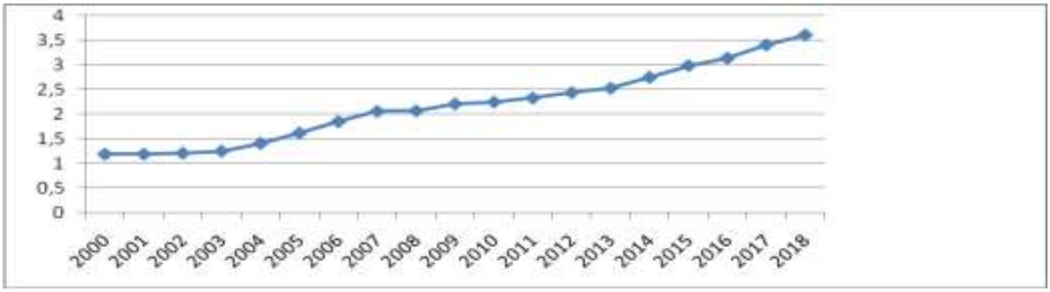
Figure (01): The energy index in Algeria from 2000 to 2018



Source: Prepared by the researcher based on data taken from NATION UNIES 2022

It is clear from the curve, which expresses the energy index as productivity capacity in Algeria, in the period 2000-2018, that the energy capacity directed to production is declining, and this decrease in energy capacity is due to the decrease in energy use and the increase in the cost of the latter, as energy prices increased by about 100 percent in five years.

Figure (02): Technological capital in Algeria for the period 2000-2018



Source: Prepared by the researcher based on data taken from NATION UNIES 2022

Through the curve, we notice the significant increase in the information and communication technology index over the years. Algeria ranked 76th at the global level in 2019 with regard to the adoption of information and communication technologies, as it advanced by 7 ranks within one year in this arrangement after it occupied the 83rd place in 2018 and reflects This result is the qualitative leap recorded by Algeria with regard to the most important indicators adopted in order to achieve this arrangement.

As for the mobile phone subscriptions index, Algeria ranked 61st globally in 2019, while it was under
It ranked 66th in 2018 and 109th in 2016, meaning that it has advanced by 48 ranks since 2016.

Algeria ranks 35th in high-bandwidth mobile Internet in 2019, after it ranked 44th in 2018 and 91st in 2016, meaning that it has advanced 63 ranks since 2016.

With regard to the number of Internet users, Algeria moved from the 106th position in 2016 to the 91st position in 2018, to settle at the 83rd position in 2019, making progress by 23 positions since 2016.

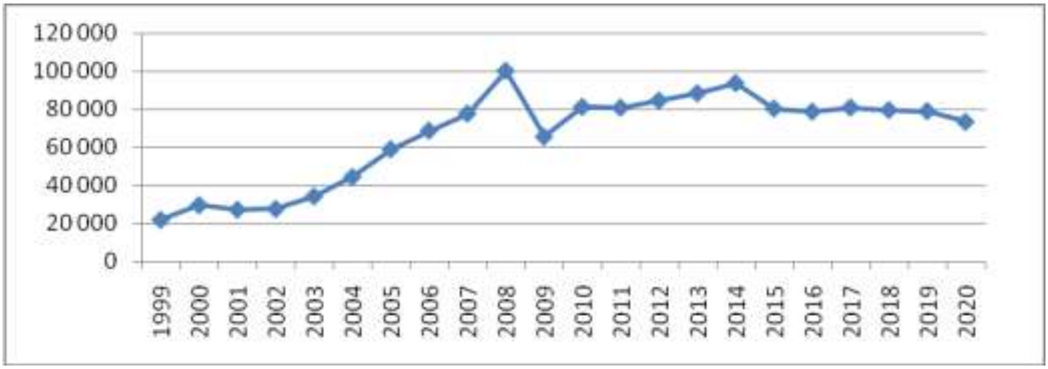
This new arrangement embodies "the efforts made by the Algerian state to develop the information society and improve access to the Internet for all citizens," according to the Global Competitiveness Report issued by the World Economic Forum for the year 2019.

3.2.The dependent variable (total productivity):

We call “total factor productivity” or (TFP or multifactor productivity) the ratio of the value of production (quantity produced) to the total value of the means of production used (labor and capital). Labor productivity and capital productivity are partial productivity measured assuming that they can be isolated from each other. Total factor productivity measures the efficiency of the productive combination of labor and capital.

Total factor productivity is generally measured at the level of a country or economic region. It can also be measured by volume (real values). Its evolution over time makes it possible to assess the relative increase in wealth (or "growth") other than that associated with the use of the factors of production, which are labor and capital (Jean-Christophe Bureau, 2023)

Figure (03): Productivity in the industrial sector in Algeria for the period 1999-2020



Source: Prepared by the researcher based on data taken from NATION UNIES 2022

We note from the curve that Algeria recorded a continuous growth in productivity in the industrial sector from 1999 until 2008, when it knew the highest value recorded about $ 100 million, and it declines in the following year 2009, then it begins to rise and improve until the year 2020, and this improvement is due To amend the investment law and revitalize its movement in Algeria and to provide some tax concessions in the industrial field, in addition to the improvement in oil prices, which witnessed a deterioration starting from the second half of the eighties, especially since the largest proportion of investment is acquired by this fuel sector on the one hand, and on the other hand beginning improvement in the political climate.

Note: In the standard study, data from 2000 to 2018 were used to agree with the rest of the data provided within the limits of the study.

4. Identification of the standard model:

To answer the research problem, we relied on a set of variables capable of influencing and explaining the total productivity of the industrial sector in Algeria during the period 2000-2018 with semi-annual data. From a methodological point of view, we chose to evaluate the contribution of the information and communication technology sector to economic growth in Algeria from the Solo model, which It is based on the production function (or technology) of the Cobb Douglass homogeneous type Homogeneous to neutral technical progress $Y=F(A,K,L)=AK^{\alpha}L^{\beta}$ In this expression A represents total factor productivity in which relative variation (technical progress) represents a portion of growth in output that is not explained by amounts of capital and labor. The coefficients α and β respectively represent the production elasticity of labor and capital. For businesses looking to reduce costs and under conditions of competition in factor markets, these transactions correspond to the shares of each of the various factors of production in costs. (Jorgenson and Stiroh, 2000; Jorgenson, 2001; Jill & Lorty, 2003).

Thus, the following form was formulated:

$GDP= A L^{\alpha} K^{\beta}$………… (1)

A: Technical lab

α, β: input shares

L: work

K: capital

$$GDP = f(KH\tau, KTIC\tau, KN\tau, EGIE\tau, TP\tau)$$

This standard model is estimated according to the multilinear model:

$$\mathrm{GDP}\tau = \beta_0 + \beta_1 KH\tau + \beta_2 KTIC\tau \quad + \beta_3 KN\tau \quad + \beta_4 EGIE\tau + +\beta_5 TP\tau + \varepsilon$$

GDP: represents the total productivity of the industrial sector.

KH: represents the human capital used in productivity.

KTIC: stands for information and communication technology used in productivity.

KN: represents the natural capital used and it expresses part of the capital used in productivity.

EGIE: Energy used in productivity.

TP: represents the transport used in the production process.

1β,2β, 3β,4β,5β,0β: represent the estimation parameters for the independent variables (model parameters)

ε: random error.

4.1.Variable stability test:

The time series stability test in standard studies that rely on time series data is very important in order to avoid misleading and false conclusions and analyzes in case of instability. (ADF), where these tests reveal the stability of the time series and determine the order of their integration.

And accordingly, to test the stability of the time series of the variables of the study model, we did the unit root test, first using the developed Dickey-Fuller test, the latter can be explained through the following equation:

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_1 \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots (4)$$

Where ε_t is a residual that is not self-correlated and has the desired properties (White Noise), and to determine the appropriate length of time gaps m, criteria such as (Schwarz Info Creterion) are usually used. The null hypothesis $\delta = 0$, that is, the existence of the unit root (the chain is unstable), is tested against the alternative hypothesis $\delta < 0$ (the chain is stable) by statistically comparing (τ) estimated for parameter (δ) with the tabulated values of (Dickey-Fuller) also developed by (Mackinon). If the absolute value of the estimated statistic exceeds the absolute value of (DF) or (Mackinon), then it is statistically significant, and therefore we reject the null hypothesis that there is a unit root, that is, the time series is stationary.If it is less than the tabulated value, then the unit root hypothesis cannot be rejected, that is, the series is non-stationary, and therefore we test the stability of the first difference of the series, and if it is unstable, we repeat the test for the difference of a higher degree... and so on .

In order to test the stability of the variables according to the ADF methodology, the following three models must be estimated:

$$\Delta x_t \rho x_{t-1} - \sum_{j=2}^{m} \Phi_j \Delta x_{t-j+1} + \varepsilon_t$$

$$\Delta x_t = \rho x_{t-1} - \sum_{j=2}^{m} \Phi_j \Delta x_{t-j+1} + c + bt + \varepsilon_t$$

$$\Delta x_t = \rho x_{t-1} - \sum_{j=2}^{m} \Phi_j \Delta x_{t-j+1} + c +$$

$$avec\ \ \varepsilon_t \backsim iid, \quad \varepsilon_t \backsim N(0,\sigma_\varepsilon^2)$$

Secondly, we used the Phillips-Perron (PP) test, whose estimate is based on the same Dickie-Fuller models, but it differs from it in that it takes into account errors with inhomogeneous variance.

Using the 10 Eviews program for time series analysis, we tested the stability of the study variables, and the results of this test are shown in the following two tables, noting that the optimal delay period m varies from one variable to another according to the Schwarz criterion for the Dickie-Fuller test and for the Philippe Peron test.

Table (01): Results of the unit roots test for the variables using the Augmented Dickey-Fuller model)

variable	the difference	ADF				
		calculated value	The critical value is at 1%	The critical value is at 5%	The critical value is at 10%	the decision
GDP	GDP	-1.39	-3.63	-2.94	-2.61	A H0
	D(GDP)	-3.09	-2.63	-1.95	-1.61	R H0
KH	KH	-1.07	-3.63	-2.94	-2.61	A H0
	D(KH)	-4.64	-3.63	-2.95	-2.61	R H0
KTIC	KTIC	-0.21	-3.63	-2.94	-2.61	A H0
	D(KTIC)	-3.54	-3.63	-2.95	-2.61	R H0
KN	KN	-1.63	-3.63	-2.94	-2.61	A H0
	D(KN)	-2.84	-3.63	-2.94	-2.61	R H0

TP	TP	-6.17	-3.63	-2.94	-2.61	RH0
EGIE	EGIE	-3.35	-4.24	-3.54	-3.20	R H0

Source: Prepared by the researcher based on the results of the program Eviews 10

Table (02): The results of the unit roots test for the variables using the Phillips-Perron (PP) model:

variable	the difference	PP				
		calculated value	The critical value is at 1%	The critical value is at 5%	The critical value is at 10%	the decision
GDP	GDP	0.85	-3.62	-2.94	-2.61	A H0
	D(GDP)	-2.66	-2.63	-1.95	-1.61	R H0
KH	KH	-0.46	-3.62	-2.94	-2.61	A H0
	D(KH)	-2.46	-2.63	-1.95	-1.61	R H0
KTIC	KTIC	-2.28	-3.62	-2.94	-2.61	A H0
	D(KTIC)	-3.40	-3.63	-2.94	-2.61	R H0
KN	KN	-1.63	-2.63	-1.95	-2.61	R H0
EGIE	EGIE	-2.82	-3.62	-2.94	-2.61	R H0
TP	TP	-3.13	-3.62	-2.94	-2.61	R H0

Source: Prepared by the researcher based on the results of the program Eviews 10
A:accept R: reject

Through the above two tables, the results of the tests show that with different levels of significance (1%, 5%, 10%), and by using the ADF and PP test, we find the conclusion that all series are not static at level (0) I and static from (1) I and Thus, the approach we follow in this case is the Autoregressive Distributed Delay (ARDL) approach, that is, the co-integration test using the limits approach as an expression of the possibility of a long-term equilibrium relationship.

The approach used in this study is the Autoregressive Time Distributed Delay (ARDL) approach developed by Pesaran and Pesaran (1995), Pesaran and Smith (1998), Pesaran and Shin (1999), Pesaran and al (2001). A modern approach to cointegration has advantages over other standard models that deal with the measurement of long-run equilibriumrelationships and cointegration that depend on VAR autoregressive models such as Johansen's model and VECM's error-corrected model.

4.2. Autoregressive slow distributed time lag (ARDL) test:

After verifying the stability of the time series of the study variables, the applied study model is estimated, which is the application of the ARDL autoregressive model test, as this method is very sensitive to the number of slowdowns of both the dependent variable and the independent variables (explaining it) through the Eviews program. .

So for the optimal delay period for the values of variables in the UECM unconstrained error correction model, 10Eviews time series analysis program provides four different criteria to determine this period: Akaike criterion (AIC), Shwarz criterion (SC), Hannan and Quinn (HQ) criterion and Adjusted R-squared standard. After estimating this model at different delay periods (p and q take values from 1 to 2), the delay period did not exceed 4 due to the small size of the sample. By choosing the optimal delay period automatically and after testing all the criteria, it was concluded that the optimal delay period, which represents the lowest value of the mentioned criteria, is (Lag = 2) for all variables, and we determined it according to the dependent delay periods: 2 (fixed)

On this basis, the best delay period was chosen (Lag = 2), in order to avoid the problem of autocorrelation

The test results of the ARDL autoregressive model are presented in the appendices.

• Estimation of the ARDL Autoregressive Lagging Distributed Time Lag Model according to the first model:

Before estimating the ARDL model and analyzing its results, some tests must first be conducted in order to ensure that the necessary conditions that prove the validity of the study are met, as follows:

Bounds Test:

The purpose of the Bounds Test is to see if there is a long-term equilibrium relationship between the variables (cointegration), based on the estimated model (UECM model).

We test the following hypothesis:

$$\begin{cases} H_0: \theta_1 = \theta_2 = \theta_3 = \theta_4 = \theta_5 = 0 \\ H_1: \theta_1 \neq \theta_2 \neq \theta_3 \neq \theta_4 \neq \theta_5 \neq 0 \end{cases}$$

H_0: There is no cointegration relationship between the variables

H_1: There is a cointegration relationship between the variables.

Table (03): Cointegration test results using the limits test

F-Bounds Test | Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	5.942123	10%	2.08	3
K	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15
			Finite Sample:	
Actual Sample Size	35		n=35	
		10%	2.331	3.417
		5%	2.804	4.013
		1%	3.9	5.419

Source: Eviews 10

It is clear from the above table that the value of the calculated F statistic is equal to 5.942123 greater than the higher critical values at each of the significant 1% (4.15), 2.5% (3.73), 5% (3.38) and 10% (3), i.e. rejecting the null hypothesis and accepting The alternative hypothesis is that there is cointegration between the variables. This confirms the rejection of the null hypothesis H0 and confirms the existence of a long-term equilibrium relationship between the variables under study.

Accordingly, since the hypothesis of co-integration between the variables has been accepted, and before estimating the model in the long and short terms, we perform diagnostic tests of the model to ensure its validity.

Therefore, based on the UECM model, we extract the impact of the independent variables on the dependent variable in the short and long term.

Diagnostics Teste for the validity of the chosen

• Standard model:

The results of the diagnostic tests for the validity of the model, and through the results of Table No. (4-5), indicate the following:

The Lagrangian statistic (LMTest) indicates that our model is free from the autocorrelation problem, and this is considered evidence that the chosen slowing period is really an optimal slowing period. The probability value (prob) is greater than the level of significance 5%, and therefore we accept the null hypothesis that there is no serial correlation, and also the graphic representation of the residuals are all confined within the confidence interval.

Table(04): Autocorrelation test

Test Statistics	LM Version	F Version
Serial Correlation (LM test)	Chi-Square(1)= 1.464052 Prob. = 0.2263	F(1,16)= 0.698499 Prob= 0.4156

Source: Prepared by the researcher based on the results of the program Eviews 10

We notice from the table that the value Prob.chi -square is greater than the level of significance 5%, which is equal to 0.2263, and therefore we accept the null hypothesis that there is no serial autocorrelation between random errors of the first order.

Table (05): Normality test results

Test Statistics	LM Version	F Version
Normality	Jarque-Bera= 0.317121 Probability= 0.853371	

Source: Prepared by the researcher based on the results of the program Eviews 10

The Jarque-Bera Test statistic, shown in Table IV-5 below, indicates that the hypothesis that the random errors are normally distributed in the estimated model is not rejected, because the probability value of this test was 0.85, which is greater than 0.05, and this indicates that it is not significant. At the level of 5% and thereof the rest distributed normally

Table (06): Heteroscedasticity

Test Statistics	LM Version	F Version
Heteroskedasticity	Chi-Square(1)= 0.005212 Prob. = 0.9424	F(1,32)= 0.004906 Prob.= 0.9446

Source: Prepared by the researcher based on the results of the program Eviews 10

It is clear from the table that the value of Prob.chi -square in the model is greater than the level of significance 5%, which is estimated at 0.9424, and this confirms the alternative hypothesis, which states that there is no stability of the discrepancy between errors and the rejection of the null hypothesis.

Table (07): RESET

Test Statistics	LM Version	F Version
Ramsey RESET Test	t-statistic =0.145051 Prob= 0.8865	F(1,8)= 0.021040 Prob= 0.8865

Source: Prepared by the researcher based on the results of the program Eviews 10

F. Based on the results of the diagnostic tests of the estimated model, a decision can be made on the validity of using this model in estimating the relationship between the total productivity of the industrial sector and its determinants of human capital, capital of information and communication technology, natural capital, energy and transportation that express The capital used in the production process.

• Long-run model estimation using the ARDL model:

Given that the results confirmed the existence of a joint integration between the variables under study, this necessitated by estimating the long-term equilibrium relationship within the framework of the ARDL model. The estimators of the parameters were obtained as shown in the following equations tables:

Figure (04): ARDL Run Form and Bounds Test

ARDL Long Run Form and Bounds Test
Dependent Variable: D(GDP)
Selected Model: ARDL(2, 2, 2, 2, 2, 2)

Case 2: Restricted Constant and No Trend
Date: 12/31/22 Time: 00:02
Sample: 2000S1 2018S2
Included observations: 35

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-41.76177	18.02267	-2.317180	0.0332
GDP(-1)*	-0.529978	0.090457	-5.858915	0.0000
CH(-1)	-0.288961	0.135609	-2.130839	0.0480
CTIC(-1)	0.872938	0.415974	2.098541	0.0511
CNATR(-1)	2.196042	0.580288	3.784401	0.0015
ENERGIE(-1)	0.828443	0.710538	1.165938	0.2597
TRANS(-1)	0.519129	0.305328	1.700235	0.1073
D(GDP(-1))	0.767782	0.142093	5.403367	0.0000
D(CH)	-1.749702	0.343085	-5.099911	0.0001
D(CH(-1))	0.874207	0.420359	2.079669	0.0530
D(CTIC)	0.691764	1.963448	0.352321	0.7289
D(CTIC(-1))	2.227253	1.632253	1.364527	0.1902
D(CNATR)	3.790782	0.554888	6.831612	0.0000
D(CNATR(-1))	-2.521692	0.782650	-3.221991	0.0050
D(ENERGIE)	0.052974	1.005300	0.052695	0.9586
D(ENERGIE(-1))	-1.252628	0.869464	-1.440690	0.1678
D(TRANS)	0.519861	0.342511	1.517793	0.1474
D(TRANS(-1))	-0.466473	0.287082	-1.624878	0.1226

* p-value incompatible with t-Bounds distribution.

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CH	-0.545231	0.240647	-2.265689	0.0368
CTIC	1.647120	0.671679	2.452241	0.0253
CNATR	4.143644	0.670038	6.184190	0.0000
ENERGIE	1.563164	1.278070	1.223066	0.2380
TRANS	0.979529	0.518414	1.889474	0.0760
C	-78.79902	28.69523	-2.746067	0.0138

EC = GDP - (-0.5452*CH + 1.6471*CTIC + 4.1436*CNATR + 1.5632*ENERGIE
+ 0.9795*TRANS -78.7990)

Source: Eviews 10

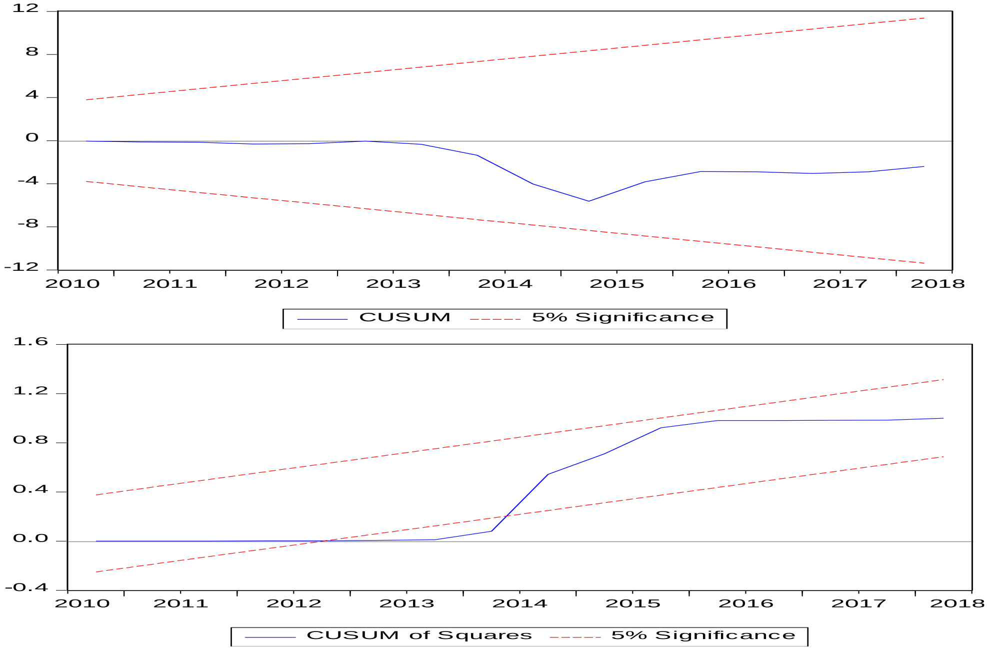
• **Results Short -term parameter estimation model:**

CointEq(-1) error correction coefficient, which measures the strength of the return towards equilibrium, and since it is negative and significant at the 1% level of significance, the error correction model is acceptable. This confirms the existence of a long-term equilibrium relationship between the total productivity of the industrial sector as a dependent variable and the variables that explain it.

It is clear to us from the error correction parameter (-0.529), that the equivalent of 53% of the deviation of the total productivity in the industrial sector in the short run is corrected from its equilibrium value in the long run in less than a year, because the correction coefficient exceeded (-1), As the mechanisms and mechanisms of productivity will adjust about half of the imbalances, especially since productivity needs the infrastructure supported by the state, that is, the imbalance is corrected in less than a year by 53%, and this highlights the effective role of this coefficient in achieving balance in the long term by ensuring that it does not Error expansion.

Through R^2, it is clear to us that 97% of the changes in productivity in the industrial sector in Algeria are explained by changes in the variables included in the study, and this indicates the validity of the model.

Figure (05): Structural stability test of ECM-ARDL transactions



Source :Eviews 10

The CUSUM and CUSUMSQ figures that the estimated coefficients of the equation are structurally stable during the study period. As for the CUSUMSQ figure, the estimated coefficients of the equation are structurally unstable for the period 2012-2014. As for the rest of the years, they are stable.

4. Conclusion:

With regard to the hypothesis, we concluded that there is a negative effect of the energy resource on the total productivity in the industrial sector in Algeria in the short term, and the effect is not significant in the long term, and this is due to the increase in the cost of energy for productivity.

Concerning the second hypothesis, we have reached positive results of the impact of information and communication technology on the total productivity in the industrial sector in Algeria. This is by reason of several factors, the most important of which is the increase in efficiency and effectiveness provided by this technology as a means to raise productivity.

The study aimed to estimate whether the impact of investment in information and communication technology or in energy raises more than the total productive capacity in the industrial sector in Algeria, based on the analysis of the test method of autoregressive distributed delay periods (ARDL), which is a modern standard technique in the analysis of cointegration and modeling. Error correction allows for more accurate and efficient results.

Some determinants of total productivity in Algeria were used as control variables in order to test an optimal model, and to avoid standard problems resulting from the lack of explanatory variables.

And it became clear through the use of co-integration that the total productivity variable in the industrial sector was associated with a joint complementary relationship with human capital, technology and natural resources in addition to the energy factor and transportation. This means that there is a long-term equilibrium relationship, and therefore the relationship was estimated using the error correction model Restricted that shows the existence of the relationship in the short term. Accordingly, the results of the dynamic analysis through integration tests in the long and short term are as follows:

The impact of information and communication technology on the total productivity of the Algerian industrial sector: The results showed that there is a positive and significant impact in the short and long term of the information and communication technology variable on the total productivity in the Algerian industrial sector, meaning that a change in information and communication technology by 1% will affect the Productivity in the industrial sector was 222% in the short run (period t-1), and was significant and positive in period t, but it was not significant. In the long run, it was estimated at 1.647, or 164%.

The impact of energy on productivity in the industrial sector in Algeria: The results showed that there is a negative and significant impact in the short term and insignificant in the long term for the energy variable on productivity, meaning that a change in the degree of energy by 1% will negatively affect productivity in the industrial sector by 125% in The short term in the period (t-1), which is consistent with the results of studies confirming that the rise in energy prices negatively affects the productive competitiveness of the industrial sector, and this is what Mathieu Bordigoni concluded. In his study:

“L’impact du coût de l’energie sur la compétitivité de l’industrie manufacturière,” where he concluded in his study that energy, especially after its high cost, negatively affects productive competitiveness, especially since energy policy knows the lack of uncertainty at the global level.

So it should be noted that investment in information and communication technology will benefit the total productivity in the industrial sector, unlike investment in energy, and this is due to the increase in the cost of energy materials for the industrial sector, the lack of energy resources, together with the difficulty of prospecting and exploration, and this is what will cost exorbitant investments that can return With material losses on national companies investing in this field.

For this reason, we recommend encouraging foreign investment in the field of energy, because giant and pioneering companies are able to bear the costs of this type of investment. As for internal investment, we recommend directing it towards the information and communication technology sector, especially encouraging emerging companies in this field. The field, given that the costs are low and that the industry is positively affected by information and communication technology.

5. Bibliography List:

1. Mali, P. (1978). *improving total productivity.* New York: John Wieyand sons.
2. Al-sulmi, A. (1994). Productive management office of the new administration. caire.
3.(IEPF), I. D. (NUMÉRO 32 - 3e TRIMESTRE 1996). *énerie et production industrielle.* France
4. ibrahim, A. H. (1990). Productive efficiency in the Arab industry. *Arab Industry Development Journal* , 22.
5. OCDE. (1955). Productivity measurement concept. *Paris ocde August*. Paris.
6. Pratt, M. K. (2019, 07). ICT (information and communications technology, or technologies). *TechTarget* .
7.Dale W. Jorgenson and Kevin J. StirohU.S. Economic Growth at the Industry Level AMERICAN ECONOMIC REVIEW VOL. 90, NO. 2, MAY 2000
8.Jean-Christophe Bureau, Anton Jesus Agricultural Total Factor Productivity and the environment: A guide to emerging best practices in measurement hal.science
9.Fossil Fuels, Steam Power, and the Rise of Manufacturing The Industrial Revolution .KHAN ACADEMY
10. ONU. (n.d.). *UNCTAD.* Retrieved 05 10, 2022, from https://unctadstat.unctad.org/wds/TableViewer/summary.aspx