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Measuring the impact of the knowledge economy in promoting the economic and environmental dimension of sustainable development

The case of Algeria for the period (1980-2021)

Zohra Khechiba [1] [*], Guedda Hayat [2]
[1] El oued University (Algeria), khechiba-zohra@univ-eloued.dz
[2] El oued University (Algeria), guedda-hayat@univ-eloued.dz

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Abstract:
This study aimed to analyze the reality of sustainable development in Algeria and the changes in indicators of the knowledge economy, as well as standard modeling of the impact of the knowledge economy on the economic and environmental dimension of sustainable development in Algeria, and to address the problem of the subject and test its hypotheses as well as achieve this goal. The study used annual data for a time series during the period (1980-2021) for each of the indicators of the knowledge economy and the indicators of sustainable development as follows: primary school enrollment, fixed telephone subscriptions (per 100 persons), mobile phone subscriptions (per 100 persons), foreign direct investment, net inflows as indicators of the knowledge economy, and gross product growth and arable land as indicators of sustainable development (the economic and environmental dimension), and the Eviews 10 economic measurement program was used to estimate the model and use unit root tests to study stability and test co-integration according to the autoregressive distributed deceleration (ARDL) approach to test the existence of a relationship in the long and short term among the variables under study.

Through the aforementioned tests, the results proved the existence of a relationship in the long and short terms between the indicators of the knowledge economy included in the model and the indicators of sustainable development, including economic and environmental, in Algeria during the studied period.

Keywords: knowledge economy, sustainable development, autoregressive distributed delay (ARDL) approach
JEL Classification: … ; … ; …

[*] ***Corresponding author.***

Introduction

The world is currently witnessing terrible progress in all economic fields, the basis of which is due to the density of knowledge and not to physical capital. In the past, knowledge was used in the process of converting available resources into goods and services. Nowadays, the role of knowledge is no longer limited to transforming resources, but rather exceeds its role. This becomes the creation of new resources that are considered the basis for the generation, increase and accumulation of wealth, which was the main concern of economics thinkers, and from here appeared in the past few decades the development of a new concept known as the knowledge economy in which knowledge represents the main determinant of productivity and economic growth, and the knowledge economy is a modern global trend seeking countries and communities by benefiting from knowledge and shifting from the economy of industries to the information economy and from the production of goods to the production of information, and the creation of a digital economy centered on communication and information networks and based on the power of information, knowledge and human capital, and emerged as a result of the shift from the traditional economy to the knowledge economy companies with a new character Technical and service sector companies such as (Microsoft, Apple, Amazone, Facebook, Google...) are at the forefront of the economic scene, while giant companies such as the automotive industry, oil and gas companies, and others have receded.

On the other hand, Algeria, like the countries of the world, faces a challenge represented by the depletion of natural resources through economic development processes, in addition to pollution of all kinds, which affects human survival, and this is what made him seek to find appropriate ways not to abandon development projects in light of preserving the environment in order to meet his needs. As a result of the above, the term sustainable development emerged, which was defined as development that provides the needs of the present without exhausting the ability of future generations to provide for their own needs.

- The problem of the study: Through this proposition, in which we showed that the knowledge economy is based on the cognitive capabilities of the human element, and that sustainable development aims to guarantee the

rights of future generations to natural resources and not to deplete them, the problem of our study was crystallized as follows:

To what extent can the knowledge economy affect the achievement of the economic and environmental dimensions of sustainable development in Algeria?

In order to answer this problem, the following questions were raised:

Is there an impact of the knowledge economy on the economic dimension of sustainable development?

- Is there an impact of the knowledge economy on the environmental dimension of sustainable development?

- Study Hypotheses: In order to answer these questions, the hypotheses were formulated as follows:

- There is an impact of the knowledge economy on the economic dimension of sustainable development.

- There is an impact of the knowledge economy on the environmental dimension of sustainable development.

- Objectives of the study:

- Highlighting the various concepts related to the knowledge economy and sustainable development.

Measuring the impact of the knowledge economy on achieving the economic and environmental dimensions of sustainable development in Algeria.

- Limitations of the study:

Temporal boundaries: The study data covers the time period from 1980 to 2021.

• Spatial limits: The limits of the study include the case of Algeria and during the time period referred to.

1- Theoretical and conceptual framework of the study.

1-1- Theoretical foundations of the knowledge economy:

The twenty-first century witnessed a fundamental shift from an industrial society to a knowledge society, as knowledge remains the driving and controlling force in a society in which information is used extensively in

various aspects of life (Daoud Al-Shara , 2015), and knowledge is defined as a set of experiences, experiences, and information. And the policies and strategies that constitute the intellectual assets of the working individuals, as they represent the understanding and awareness gained through observation, interpretation and study, where the information is transformed into practical experience that directs the behavior of those who receive it (Rebhi M. E., 2014).

1.1.1 - The concept of the knowledge economy: The researchers presented many definitions of the knowledge economy, among which we mention: "It is the economy in which knowledge achieves the greatest part of the added value, meaning that knowledge in this economy constitutes an essential component in the production process, as in marketing, and that Growth increases with the increase of this component based on information and communication technology as the starting point for this economy (Haj Muhammad , 2014).

It was also defined as "the economy that revolves around obtaining knowledge, sharing it, using it, employing it, creating it, and producing it with the aim of improving the quality of life in all its fields, by benefiting from rich information services, advanced technological applications, using the human mind as a valuable knowledge capital, and employing scientific research to create a group From the strategic changes in the nature and organization of the economic environment to become more responsive and in line with the challenges of globalization, information and communication technology, the universality of knowledge and sustainable development in its holistic and integrative concept (Rebhi E. M., 2014).

The Organization for Economic Cooperation and Development defines a knowledge-based economy as "an economy in which knowledge is the main determinant of productivity and economic growth by focusing on a new role for information, technology and learning in achieving distinguished economic performance."

The knowledge-based economy is considered an advanced stage of the knowledge economy. The major industrial countries that have benefited from the achievements of the scientific and technological revolution and harnessed them in industries that generate new knowledge, discoveries and

advanced technologies have reached the stage of the knowledge-based economy, or what we can call the post-knowledge economy stage. As for the countries that seek to produce knowledge through innovation, acquisition, dissemination, use and storage of knowledge, they are still in the phase of the knowledge economy (Bourisha , 2022).

Through the previous definitions, we say that the knowledge economy is that economy in which knowledge replaces primary resources and financial assets in creating added value with the aim of improving various areas of life, which requires focusing on developing the capabilities, skills and expertise of human resources, which represent the main factor in the production, sharing, use and employment of knowledge. In addition to benefiting from information and communication technology, which is the starting point for this economy.

1.1.2 - Foundations of the Knowledge Economy: The United Nations program for assessing the levels of knowledge management in the societies of different countries of the world tended to consider four main factors as the main elements that are basic criteria in determining the level of pursuit of national economies towards achieving the information society based in most of its activities on These factors included four essential pillars (A. Bo Al-Qudra , 2018):

The first pillar - economic incentives and institutional systems: It includes a number of variables that fall under three main axes: customs tariff, quality of regulation, and the rule of law, as follows:

-Customs tariff: Obstacles related to the presence or absence of a customs tariff, which is a measure of the degree of competition in the market.

-Regulatory quality: It is a measure of the cases of market policies that try to control prices or the absence of proper supervision of banks and the strict determinants that are adopted in areas related to foreign trade, as well as the mechanisms of development in trade and business.

- The rule of law: It represents a measure of the amount of confidence that the client considers an indication of his ability to work and invest within the laws of society in light of incidents arising from ordinary crimes or arising from manifestations of violence and the extent of the effectiveness of the

judicial authority towards it, and the possibility of executing contracts and adhering to their content.

The second pillar - education and human resources: the level of this factor is assessed in the light of variables related to the level of enrollment of citizens in the various stages of education, which can be considered a criterion for the level of reading and writing for adults and provide at the same time a measure for the size of enrollment in school stages and the level of culture prevailing in society. The level of spending on education in its various stages, the size of skilled human resources in society and the level of their training are taken into account. Are minds suffering from the issue of migration as a result of the lack of appropriate conditions in society to embrace it?

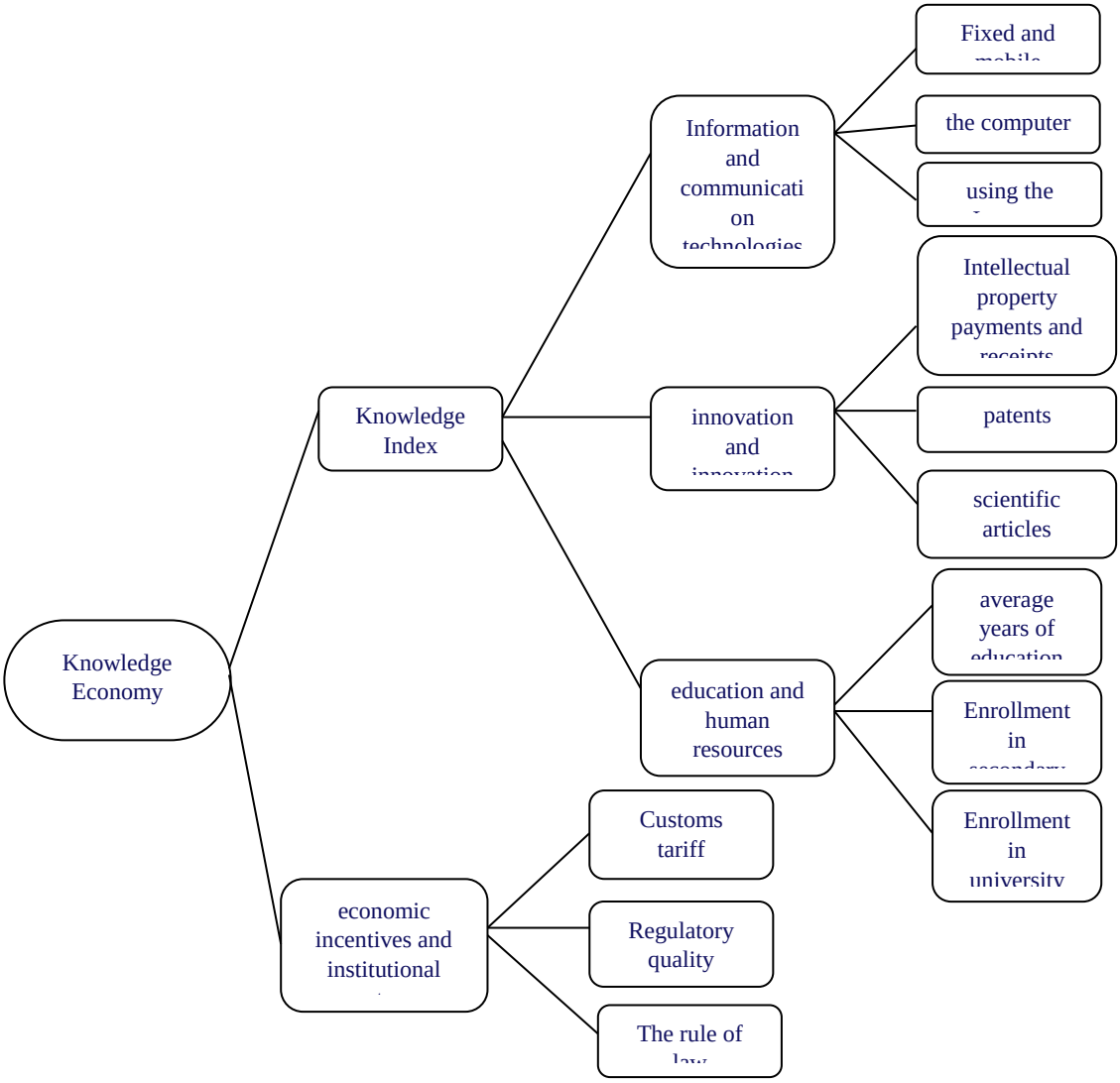
The third pillar - innovation and innovation: The variables of this pillar were based on the number of researchers per million inhabitants, patents registered by researchers, research and scientific articles published in the fields of pure science and applied technologies, in addition to the volume of investments allocated to research and development activities in each of the government sectors. and the extent to which financial support is available for young projects that have grown up in national technical incubators.

The fourth pillar - the information and communication infrastructure: It is the solid ground on which knowledge-based economy activities grow. Information in accessing the Internet or field applications, in addition to the types of information technologies prevailing in the national environment that contribute to the optimal investment of information flow. The level of sovereignty of e-government services and the size of spending on information infrastructure are also taken into account.

The World Bank has also adopted these pillars in defining the parameters of the general framework for measuring the Knowledge Economy Index, as the latter is measured by a mathematical model that employs a series of calculations through which the average value of the indicator for a country is measured, based on the values of the four pillars of the knowledge economy. As for the Knowledge Index, its equation is based on three pillars after excluding the variables of the economic system.

Figure No. (01) shows the foundations of the knowledge economy pursued by the World Bank:

Figure 01: Represents the World Bank's methodology for measuring the Knowledge Index(KI) and the Knowledge Economy Index (KE)



Source: A. Bou El Qudra Naziha (2018), Knowledge Economy in Algeria - An Analytical Study in the Alternative Framework of the Traditional Economy, Journal of Advanced Economic Studies, No. 07, Algeria, p. 375.

1-2- Sustainable Development: Major problems have emerged as a result of economic development projects carried out by man and cause environmental damage, such as: pollution of soil, water and air, poverty of agricultural lands, decline in food production, as well as the spread of dangerous and fatal diseases for humans, the phenomenon of global warming and the erosion of a large part of The ozone layer...etc., the situation that threatens human survival, which made him seek appropriate ways not to abandon development projects in light of preserving the environment in order to meet his needs, and as a result of the above, the term sustainable development appeared (Al-Rifi , 2015).

1.2.1 - The concept of sustainable development: The term sustainable development appeared for the first time in the report of the International Union for Conservation of Nature in 1980, and since the term carries many dimensions, its definitions have multiplied according to the intellectual background of the researchers, and it seems that the comprehensive definition came in the report of the World Commission for the Environment And development chaired by Bruntland issued in 1987, where he defined sustainable development as development that provides the needs of the present without exhausting the ability of future generations to provide for their own needs, as defined by the United Nations as development that can last forever, or at least for a very long time (Al-Janabi , 2017).

The FAO defines sustainable development as: "management and protection of the natural resource base and directing technical and institutional change in a manner that guarantees the realization and continued satisfaction of human needs for present and future generations. Technically appropriate, economically appropriate and socially acceptable (Sardar , 2015).

As defined in the report of the International Union for the Conservation of Natural Resources and sustainable development is "the constant endeavor to appreciate the quality of human life, taking into account the capabilities and capabilities of the natural system that embraces life (Boukna , 2018)."

From the above and our contribution, we define sustainable development as development that meets the needs of current generations without prejudice to the rights of future generations, by guaranteeing their rights to natural

resources and not depleting them, and preserving the environment with all its components from pollution resulting from various development projects.

1.2.2 -Dimensions of Sustainable Development: Sustainable development has several dimensions, the most important of which are:

The economic dimension: It refers to a sustainable economic system that allows the production of goods and services to satisfy human needs, and to achieve prosperity continuously and permanently without harming the environment. This is by changing the current patterns of production as well as consumption that relies on natural resources in an unacceptable manner by wasting natural resources, and searching for new and effective methods to achieve sustainable economic development and meet needs without harming the environment and reducing pollution.

The social dimension: It means achieving justice in distributing wealth among individuals in society, delivering the necessary services to all groups, eliminating all differences between urban and rural residents, contributing to achieving social diversity, allowing everyone to participate in consultation and linking them to decision-making to achieve freedom in that. , while maintaining reasonable demographic growth and striking a balance with the capabilities of the government and the state and its natural resources to avoid the inability of the government to keep pace with rapid growth in light of its limited capabilities in meeting the needs and providing the necessary services to the population, which is likely to increase the poor, and then improper exploitation of wealth, and thus drain natural resources, which impedes the sustainability of development and burdens future generations.

The environmental dimension: sustainable development imposes the necessity of preserving a stable base of natural resources, by following patterns of production and using them in rational ways, to avoid the depletion of renewable energies, and to achieve biodiversity, air purity, soil fertility, and the preservation of biodiversity (Chaabani , 2014).

2-The practical and analytical framework of the study:

2.1- Study variables:

The aim of this study is to determine the effects of knowledge economy indicators on the economic and environmental dimension of sustainable development by building a standard model that shows the relationship between the dependent variables represented in the growth of gross

domestic product and arable land and the independent variables of school enrollment, primary stage and fixed telephone subscriptions (per 100 persons), mobile phone subscriptions (per 100 persons), and foreign direct investment, net inflows based on World Bank data for the period 1980-2021, and the model variables are summarized in the following table:

Table No. 01: definition of the variables of the general model of the stydy

variables	*Study priod*	*code*	*source*
GDP growth (annual %)	2021-1980	**GDP**	**World Bank data** https://data.albankaldawli.org/
Arable land (% of land area)	2021-1980	**AN**	**World Bank data** https://data.albankaldawli.org/
School enrollement, primary (% gross)	2021-1980	EPS	**World Bank data** https://data.albankaldawli.org/
Fixed telephone subscriptions (per 100 people)	2021-1980	FTS	**World Bank data** https://data.albankaldawli.org/
Mobile cellular subscriptions (per 100 people)	2021-1980	MCS	**World Bank data** https://data.albankaldawli.org/
Foreign direct investment, net inflows (% of GDP)	2021-1980	**FDI**	**World Bank data** https://data.albankaldawli.org/

Source: Prepared by researchers

2.2- Unit Root Tests:

The econometrics approach requires a study of the stability of time series to choose models, based on economic theory and the degree of integration of the time series, and the developed Dickie Fuller test (ADF) was relied upon to test whether the time series under study are stable or not, as well as to determine the degree of their integration, and the following table shows the results of the analysis ADF test:

Table No. 02: Results of Stability Test with ADF

variables	*Stability level*	*Decision*
GDP	Stable at the level	I(0)
AN	Stable at the level	I(0)
EPS	Stable at the first difference	I(1)

FTS	Stable at the first difference	I(1)
MCS	Stable at the first difference	I(1)
FDI	Stable at the first difference	I(1)

Source: Prepared by researchers based on the outputs of the strings stability tests

The results of the time series stability test showed through the above table that some variables stabilited at the level, while some variables reached the stage of rest and stability after taking the first difference for them, and this allows the possibility of applying the boundary tests method in searching for the extent of a long-term equilibrium relationship between Study variables.

2.3- Estimating the models according to the Autoregressive Distributed Deceleration (ARDL)

In this part of the study, two models will be evaluated, which are:

The first model: Measuring the impact of the knowledge economy in promoting the economic dimension of sustainable development

The second model: Measuring the impact of the knowledge economy in promoting the environmental dimension of sustainable development

2.3.1- Measuring the impact of the knowledge economy in promoting the economic dimension of sustainable development (the first model)

Since the results showed that there is a mixture of the level of integration between the variables, this is what allows the application of the limits test:

- Determining the number of gaps and slowing periods:

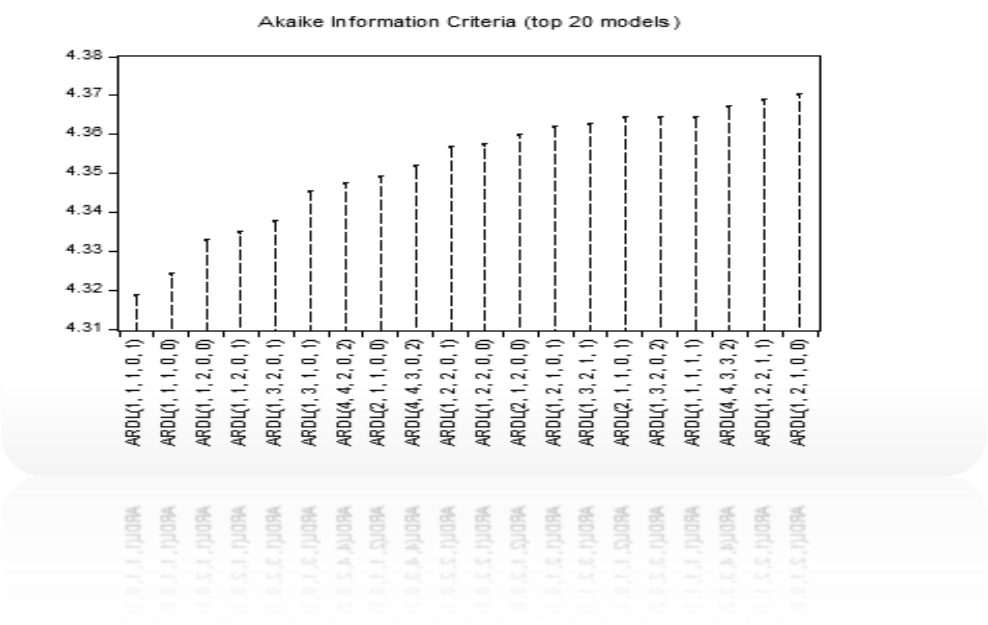
Before starting to estimate the model, it is necessary to determine the length of the lag time periods, the presence of many quantities in the late time periods will consume many degrees of freedom in addition to increasing the possibility of the emergence of the problem of multiple autocorrelation, and also the presence of a few lag time periods will lead to errors in the characterization, and is Determine the length of the distributed delay periods (n) through the following tests)Diebold(2016 ،:

- Akaki test (AIC) Akaike information criterion.

Schwarz information criterion (SC).

Where we take the period that is less than the value of these two criteria, and according to the data relied upon in this study, the best model is ARDL (1,1,1,0,1) according to the (AIC) standard, as shown in the following figure:

Figure 02: Results for determining the optimal time delay for the ARDL model for the first model



Source: Prepared by the researchers based on Eviews 10 Program

Therefore, the form is written according to the following mathematical formula:

GDP = C(1)*GDP(-1) + C(2)*EPS + C(3)*EPS(-1) + C(4)*FTS + C(5)*MCS + C(6)* MCS(-1) + C(7)*FDI + C(8)*FDI(-1) + C(9) +

- Determine the boundaries method:

The decision is made btesty comparing the calculated value of (F-statistic) with the tabular values of Paresh Kumar Narayan

Table No. 03: Results of the Bounds Test of the first model

ARDL (1,1,1,0,1)
K=4
F-statistic=6.926289

significance	I (0)	*I (1)*
%10	2.66	*3.838*
%5	3.202	*4.544*
%1	4.428	*6.25*

Source of critical values:The critical values for Paresh Kumar Narayan (2005)

Source: Prepared by the researchers based on Eviews 10 Program

It is clear from the results in the table above that the calculated value of the statistic (F-statistic = 6.926289) lies outside the upper and lower limits at all levels of significance 90%, 95%, 99% and that the value of this statistic is greater than the upper limits according to the tables (by Paresh Kumar Narayan. 2005), and therefore we reject the null hypothesis H0 and accept the alternative hypothesis H1, which indicates the existence of a long-term equilibrium relationship for both GDP growth and knowledge economy indicators.

- Estimating the relationship in the long and short term for the first model:

Since the results confirmed the existence of co-integration between the variables in the GDP growth equation as a dependent variable and knowledge economy indicators as explanatory variables, the long-term and short-term relationship of the error correction model according to the ARDL methodology were estimated in Appendix No. (01).

The parameters of the model estimated in the long and short term can be analyzed as follows:

The results of long-term parameters estimates indicate that each of the parameters of the number of fixed and mobile phone subscribers carries a negative sign, which indicates an inverse relationship between them and the GDP rate, meaning that when the number of fixed and mobile phone subscribers increases by one unit per million people, it will lead to a decrease in the rate Growth by 0.773573 and 0.028100 units, respectively, while we note the recording of a positive and significant relationship with

the positive and significant impact of each of the two variables: enrollment in primary school and net inflows from foreign investments, as an increase in inflows by one unit leads to an increase in the growth rate of 1.744162 units. As for the variable that expresses education, its increase by one unit will lead to an increase in growth by a value of 0.264356 units.

As for the dynamic model, which represents the relationship between the growth rate and indicators of the knowledge economy in the short term, using the ARDL model (1,1,1,0,1), and according to the results shown in Table No. (04), the speed of adjusting the model towards equilibrium or correction limit the error is significant and takes the negative sign as expected, in addition to its high value. Where the value of the error correction limit parameter (-0.809347) refers to the size of the growth rate adjusting towards its equilibrium value in a period of time with a percentage of the remaining imbalance from the period (t-1) at a rate of 80.9347%, that is, when the size of the growth rate deviates during the short run in The period (t-1) for the equilibrium value in the long run is corrected by the equivalent of 80.9347 % of this deviation or imbalance in the period (t).

On the other hand, this correction rate reflects a strong adjustment speed towards equilibrium, meaning that the size of the rates takes approximately 1.2355639794 years (1/0.809347 = 1.2355639794), that is, approximately 14 months 03 days towards its equilibrium value, and thus confirms the existence of an error correction mechanism in the model. .

- Diagnostic tests for the first model:

In order to ensure the quality of the estimated model before its adoption, diagnostic tests were conducted, or what is called appropriateness tests for the estimated model, as follows:

- Jarque-Bera normal distribution test: To verify the condition of following the residuals of the estimated model for the normal distribution, the (Jarque-Bera) test was used, and the test results are shown in Appendix No. (2).

The normal distribution test statistic indicates the acceptance of the null hypothesis, which states that the random errors are normally distributed in the estimated model, where the Jarque-Bera value is equal to (0.796557)

with a probability of 0.671475, which is greater than the 5% level of significance, and therefore the errors follow the normal distribution.

Heteroskedasticity Test ARCH:

In order to verify that the model does not suffer from the problem of instability of variance, we use the ARCH test for this purpose, and the results are shown in Appendix No. (2).

The value of the stability of variance statistic indicates the acceptance of the null hypothesis, which states that the variance of the random error limit is homogeneous in the estimated model, as the probability value of the Fisher Prob.F statistic is 0.7485, which is greater than 5%, and this indicates the stability of the variances of errors.

Model characterization test ((Ramsey test): by testing that the model identification error problem does not appear and the validity of the functional form, and the test results are shown in Appendix No. (2)

The information shows us that the value of the F-statistic level is equal to 0.2743, which is greater than the critical value of 0.05, and therefore we accept the alternative hypothesis that the model is well described, that is, the functional form used is suitable for the data.

- Structural stability test of the model:

The structural stability of the estimated coefficients is achieved if the graph of the statistic of (CUSUM) and (CUSUMSQ) falls within the critical limits at a significant level of 5%, and then these coefficients are unstable if the graph of the statistic of the two aforementioned tests moves outside the limits at this level, which is what It is clear from the graph that the estimated coefficients of the adopted unrestricted error correction model are structurally stable during the study period, which confirms the existence of stability between the study variables and the harmony in the model between the results of error correction in the short and long term. (See Appendix No. (2)).

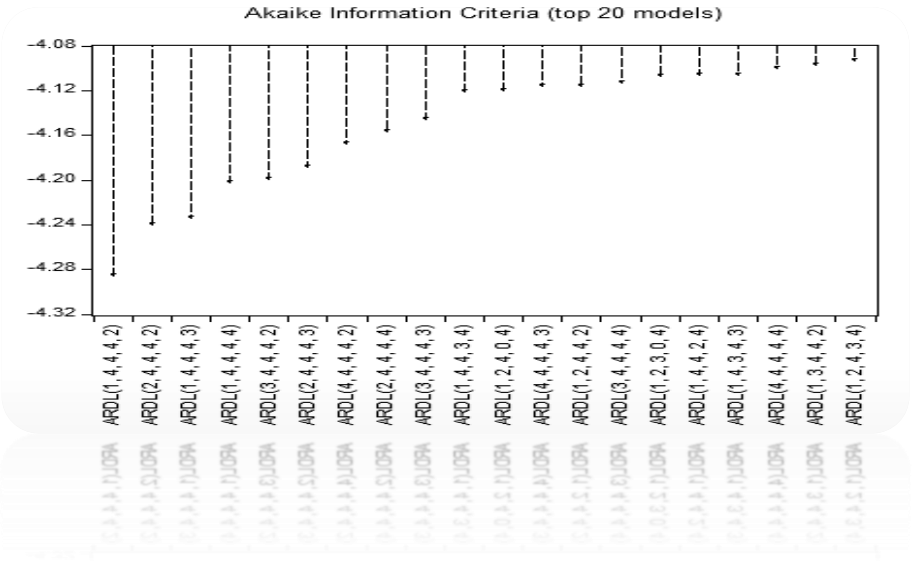
2.3-2 - Measuring the impact of the knowledge economy in promoting the environmental dimension of sustainable development (the second model)

By applying the same previous steps applied in the first model of the study, we are now conducting a regression between arable land and

knowledge economy indicators in Algeria for the period (1980-2021), we obtained the following results:

-Determining the number of gaps and slowing periods: According to the data relied upon in this study, the best model is ARDL (1,4,4,4,2) according to the (AIC) standard, as shown in the following figure:

Figure 03: Results for determining the optimal time delay for the ARDL model for the second model



Source: Prepared by the researchers based on Eviews 10 Program

He writes the form according to the following mathematical formula:

AL = C(1)*AL(-1) + C(2)*EPS + C(3)*EPS(-1) + C(4)*EPS(-2) + C(5)*EPS(-3) + C(6)*EPS(-4) + C(7)*FDI + C(8)*FDI(-1) + C(9)*FDI(-2) + C(10)*FDI(-3) + C(11)*FDI(-4) + C(12)*FTS + C(13)*FTS(-1) + C(14)*FTS(-2) + C(15)*FTS(-3) + C(16)*FTS(-4) + C(17)*MCS + C(18)*MCS(-1) + C(19)*MCS(-2) + C(20)

AL = C(1)*AL(-1) + C(2)*EPS + C(3)*EPS(-1) + C(4)*EPS(-2) + C(5)*EPS(-3) + C(6)*EPS(-4) + C(7)*FDI + C(8)*FDI(-1) + C(9)*FDI(-2) + C(10)*FDI(-3) + C(11)*FDI(-4) + C(12)*FTS + C(13)*FTS(-1) + C(14)*FTS(-2) + C(15)*FTS(-3) + C(16)*FTS(-4) + C(17)*MCS + C(18)*MCS(-1) + C(19)*MCS(-2) + C(20)

B- Cointegration Test (Test of Limits):

The test results are shown in the following table:

Table No. 04: Results of the Bounds Test of the first model

ARDL (1,4,4,4,2)
K=4
F-statistic=7.309110

significance	I (0)	*I (1)*
%10	2.427	*3.395*
%5	2.893	*4*
%1	3.967	*5.455*

Source of critical values:The critical values for Paresh Kumar Narayan (2005)

Source: Prepared by the researchers based on Eviews 10 Program

It is clear from the results in the above table that the calculated value of the statistic (F-statistic = 7.309110) lies outside the upper and lower limits at all levels of significance 90%, 95%, 99% and that the value of this statistic is greater than the upper limits according to the tables (by Paresh Kumar Narayan. 2005), and therefore we reject the null hypothesis H0 and accept the alternative hypothesis H1, which indicates the existence of a long-term equilibrium relationship for both GDP growth and knowledge economy indicators.

- Estimating the relationship in the long and short term for the second model:

Because the results confirmed the existence of co-integration between the variables in the arable land equation as a dependent variable and knowledge economy indicators as explanatory variables, the long-term and short-term relationship of the error correction model according to the ARDL methodology were estimated in Appendix No. (3). The results showed the following:

The results of long-term estimates indicate that there is a positive and significant relationship between each of the two parameters of primary school enrollment, the number of fixed-line subscribers per 100 people, and the arable land parameter, where any increase in these two variables by 01% leads to an increase in the size of arable land by 0.016277% and 0.044481 %, which is a result consistent with the concepts of the logic of economic

theory, while we note the inverse relationship between net inflows of foreign investments and arable land. Arable lands amounted to 0.17394 units.

We also notice an inverse relationship between each of the number of mobile phone subscriptions per 100 people and the rates of arable land, as an increase in subscriptions by one unit leads to a decrease in the rate of land by 0.003268 units.

As for the dynamic model, which represents the relationship between the land average and knowledge economy indicators in the short term, using the ARDL model (1,4,4,4,2), and according to the results shown in Appendix No. (3), the value of the error correction limit parameter (-0.768711) to the size of the arable land rate adjusting towards its equilibrium value in a period of time with a ratio of the remaining imbalance from the period (t-1) at a rate of 76.8711%, that is, when the size of the growth rate during the short term in the period (t-1) deviates from the value Equilibrium in the long run, it is corrected by the equivalent of 80.9347% of this deviation or imbalance in the period (t).

On the other hand, this correction rate reflects a strong adjustment speed towards equilibrium, in the sense that the size of the rates takes approximately 1.3008790039 years (1/0.768711 = 1.3008790039), that is, approximately 13 months towards its equilibrium value, and thus confirms the existence of an error correction mechanism in the model.

- Diagnostic tests for the second model:

To see if this model is sound and reliable for diagnosis and economic analysis, we perform some diagnostic tests. The test results are shown in Appendix No. (4):

By analyzing Appendix No. (4) below, the following results appear:

• When comparing the probability of Fisher, which is equal to 0.8017 and is greater than 5%, which makes us accept the null hypothesis that there is no serial correlation problem for the remainder of the regression equation.

• The value of the variance stability statistic indicates the acceptance of the null hypothesis, which states that the variance of the random error limit is homogeneous in the estimated model, as the probability value of the Fisher Prob.F statistic is 0.3799, which is greater than 5%, and this indicates the stability of the variances of errors.

• The normal distribution test statistic indicates the acceptance of the null hypothesis, which states that the random errors are normally distributed in the estimated model, where the Jarque-Bera value was (0.953038) with a probability of 0.620941, which is greater than the 5% level of significance, and therefore the errors follow the normal distribution.

• We note that the tests of the cumulative sum of the residuals (cusum) and the cumulative sum of the squares of the residuals (CUSUM of Squares), which appear through the above table for this model, is a middle line inside the critical region, indicating the stability of the model at significant limits of 5%, and therefore We accept the null hypothesis and reject the alternative hypothesis, i.e. the existence of structural stability in the model during this period. This confirms the existence of stability between the variables of the study and consistency in the model between the results of error correction in the short and long term.

Conclusion

This study addressed the problem of the role of the knowledge economy in supporting the achievement of the economic and environmental dimension of sustainable development in Algeria based on annual data during the period (1980-2021), using co-integration according to the Autoregressive Distributed Deceleration (ARDL) approach. The study reached the following results:

- Through tests of limits for co-integration, the study concluded that there is a co-integration between each of the indicators of the knowledge economy and the indicators of the economic and environmental dimensions of sustainable development, and this allows measuring the relationship in the long and short term between the variables.

The results of the long-term estimates for each of the two models indicate:

- For the first model, there is an inverse relationship for each of the indicators of fixed and mobile phone subscribers and the GDP rate, while

we notice a positive and significant relationship with the positive and significant impact of each of the variables of primary school enrollment and net inflows of foreign investment, which is consistent with most previous studies and the logic of Economic theory.

For the second model, the study found a direct and significant relationship between each of the two teachers of primary school enrollment, the number of fixed-line subscribers per 100 people, and the arable land parameter, where any increase in these two variables leads to an increase in the size of arable land. This result is consistent with the logic of economic theory. While we notice an inverse relationship between the net inflows of foreign investments, as well as the index of the number of mobile phone subscriptions per 100 people, with the arable land index.

- For the dynamic model, which represents the relationship between the rates of gross domestic product, arable land, and indicators of the knowledge economy in the short term through the negative error correction coefficient, the study showed the speed of return of both the rate of output and the rate of land to equilibrium in the long term when any changes occur in the indicators of the economy Knowledge.

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Annex (Appendices)

Appendix No. 01 :The results of estimating The first Model according to the ARDL model

Long-run coefficients

variable	*coefficient*	*Sts.Error*	*t–Statistic*	**prob**
C	-20.50877	8.713628	-2.353644	***0.0251***
GDP(-1)*	-0.809347	0.162718	-4.973926	***0.0000***
EPS(-1)	0.264356	0.096192	2.748208	***0.0099***
FTS**	-0.773573	0.311713	-2.481684	***0.0187***
MCS(-1)	-0.028100	0.017106	-1.642682	***0.1106***
FDI(-1)	1.744162	0.894109	1.950726	***0.0602***
D(EPS)	-0.575851	0.264420	-2.177793	***0.0372***

D(MCS)	0.033453	0.053449	0.625889	***0.5360***
D(FDI)	0.240023	0.792112	0.303017	***0.7639***

Short-run error correction estimates

variable	*coefficient*	*Sts.Error*	*t–Statistic*	**prob**
C	-20.50877	3.274373	-6.263420	***0.0000***
D(EPS)	-0.575851	0.221235	-2.602894	***0.0141***
D(MCS)	0.033453	0.044597	0.750133	***0.4588***
D(FDI)	0.240023	0.615254	0.390120	***0.6991***
CointEq(-1)*	-0.809347	0.129433	-6.253001	***0.0000***

The general form of the equation of the form

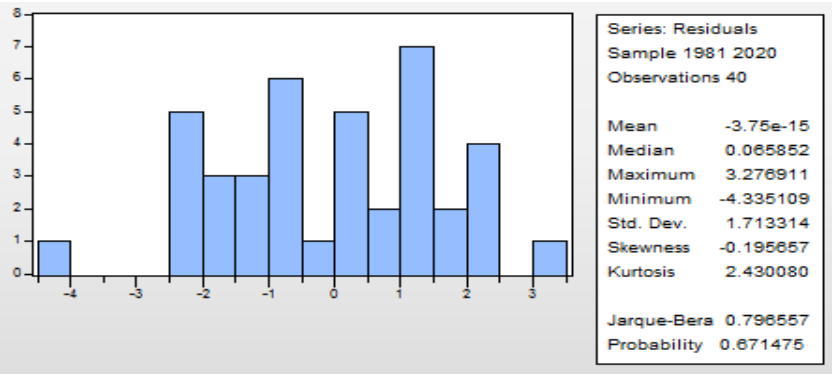
D(GDP) = -20.508773472972 -0.809347126701*GDP(-1) + 0.264355549550*EPS(-1) -0.773572806842*FTS** -0.028099817761*MCS(-1) + 1.744162083391*FDI(-1) -0.575851038348*D(EPS) + 0.033453398272*(GDP - (0.32662814*EPS(-1) -0.95579855*FTS(-1) -0.03471912*MCS(-1) + 2.15502351*FDI(-1)) + 0.240023031758*D(FDI))

Source: Prepared by the researchers based on Eviews 10 Program

Appendix No. 02: The results of diagnostic tests for first model

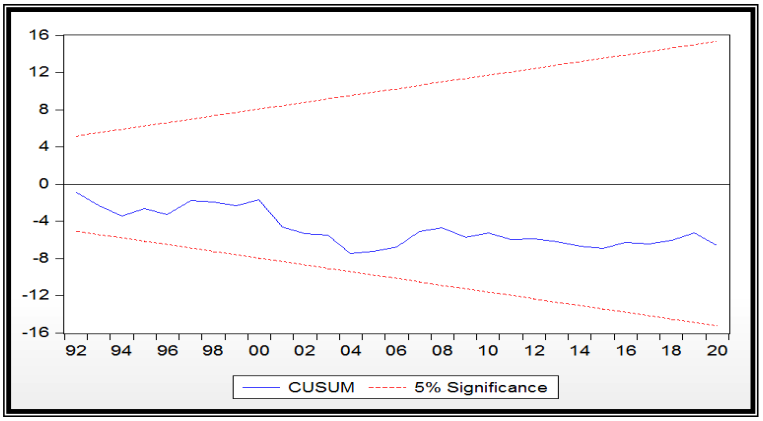
The test	*outputs*
Heteroskedasticity Test ARCH	leteroskedasticity Test: ARCH -statistic 0.104331 Prob. F(1,37) 0.7485)bs*R-squared 0.109661 Prob. Chi-Square(1) 0.7405
Ramsey test	Value df Probability tic 1.113609 30 0.2743 stic 1.240126 (1, 30) 0.2743

Normality test Jarque-Bera

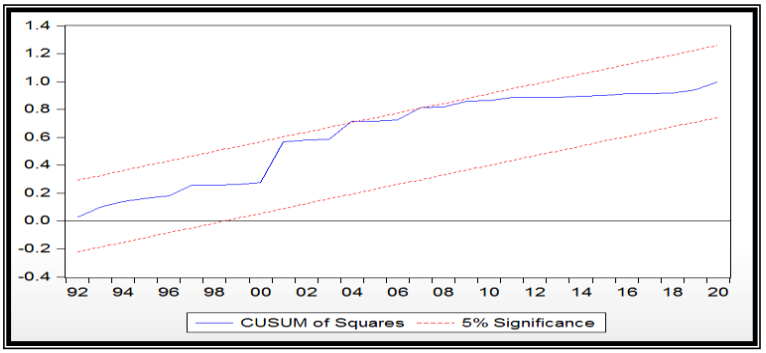


M odel stability test results

Plot of cumulative sum of the recursive residuals



Plot of cumulative sum of squares of recursive residuals-squared



Source: Prepared by the researchers based on Eviews 10 Program

Appendix No. 03:The results of estimating The second Model according to the ARDL model

Long-run coefficients

variable	*coefficient*	*Sts.Error*	*t–Statistic*	**prob**
C	0.700646	0.388705	1.802514	***0.0892***
AN(-1)*	-0.768711	0.173006	-4.443254	***0.0004***
EPS(-1)	0.016277	0.003919	4.153404	***0.0007***
FDI(-1)	-0.173945	0.041176	-4.224466	***0.0006***
FTS(-1)	0.044481	0.019246	2.311238	***0.0336***
MCS(-1)	-0.003268	0.000814	-4.014228	***0.0009***
D(EPS)	0.027820	0.006238	4.459365	***0.0003***
D(EPS(-1))	0.006073	0.005591	1.086202	***0.2926***
D(EPS(-2))	-0.005608	0.005534	-1.013257	***0.3251***
D(EPS(-3))	-0.013163	0.006102	-2.157390	***0.0456***
D(FDI)	-0.019844	0.012861	-1.543009	***0.1412***
D(FDI(-1))	0.143748	0.036071	3.985173	***0.0010***
D(FDI(-2))	0.082878	0.027943	2.965945	***0.0087***
D(FDI(-3))	0.046390	0.017943	2.585368	***0.0193***
D(FTS)	-0.038479	0.017728	-2.170445	***0.0444***
D(FTS(-1))	-0.013447	0.020301	-0.662415	***0.5166***
D(FTS(-2))	-0.030476	0.017401	-1.751424	***0.0979***
D(FTS(-3))	-0.050527	0.017608	-2.869481	***0.0106***
D(MCS)	-0.002563	0.001125	-2.278268	***0.0359***
D(MCS(-1))	0.003907	0.001422	2.747835	***0.0137***

Short-run error correction estimates

variable	*coefficient*	*Sts.Error*	*t–Statistic*	**prob**
D(EPS)	0.027820	0.004139	6.722151	***0.0000***
D(EPS(-1))	0.006073	0.003995	1.520166	***0.1468***
D(EPS(-2))	-0.005608	0.004010	-1.398380	***0.1800***
D(EPS(-3))	-0.013163	0.003692	-3.565171	***0.0024***
D(FDI)	-0.019844	0.008922	-2.224078	***0.0400***
D(FDI(-1))	0.143748	0.022333	6.436680	***0.0000***
D(FDI(-2))	0.082878	0.017599	4.709168	***0.0002***
D(FDI(-3))	0.046390	0.013392	3.463912	***0.0030***
D(FTS)	-0.038479	0.010651	-3.612663	***0.0021***
D(FTS(-1))	-0.013447	0.009857	-1.364301	***0.1903***
D(FTS(-2))	-0.030476	0.010210	-2.984980	***0.0083***
D(FTS(-3))	-0.050527	0.010176	-4.965048	***0.0001***
D(MCS)	-0.002563	0.000778	-3.292452	***0.0043***
D(MCS(-1))	0.003907	0.000981	3.984793	***0.0010***
CointEq(-1)*	-0.768711	0.102040	-7.533464	***0.0000***

The general form of the equation of the form

$$D(AN) = 0.700646007739 - 0.768710972965*AN(-1) + 0.016277408271*EPS(-1) - 0.173944729520*FDI(-1) + 0.044481139233*FTS(-1) - 0.003267527159*MCS(-1) + 0.027819740928*D(EPS) + 0.006072698854*D(EPS(-1)) - 0.005607749444*D(EPS(-2)) - 0.013163396335*D(EPS(-3)) - 0.019844181722*D(FDI) + 0.143747669998*D(FDI(-1)) + 0.082878075071*D(FDI(-2)) + 0.046389726992*D(FDI(-3)) - 0.038478607108*D(FTS) - 0.013447490704*D(FTS(-1)) - 0.030475799507*D(FTS(-2)) - 0.050526640922*D(FTS(-3)) - 0.002562514687*(AN - (0.02117494*EPS(-1) - 0.22628105*FDI(-1) + 0.05786458*FTS(-1) - 0.00425066*MCS(-1) + 0.91145571) + 0.003907208417*D(MCS(-1)))$$

Source: Prepared by the researchers based on Eviews 10 Program

Appendix No. 04: The results of diagnostic tests for second model

The test *outputs*

Breusch-Godfrey Serial Correllation LM Test(2):

sch-Godfrey Serial Correlation LM Test:

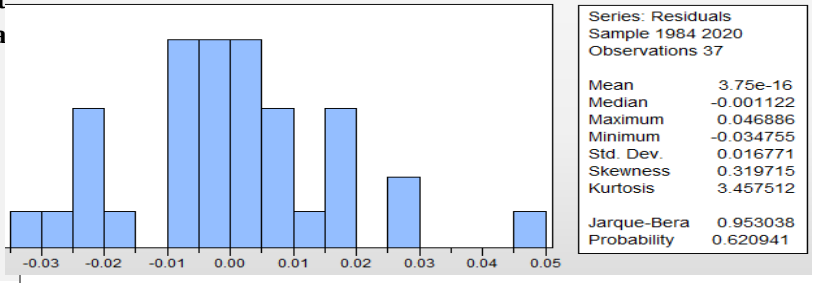
atistic	0.224285	Prob. F(2,15)	0.8017
*R-squared	1.074344	Prob. Chi-Square(2)	0.5844

Heteroskedasticity Test ARCH:

eroskedasticity Test: ARCH

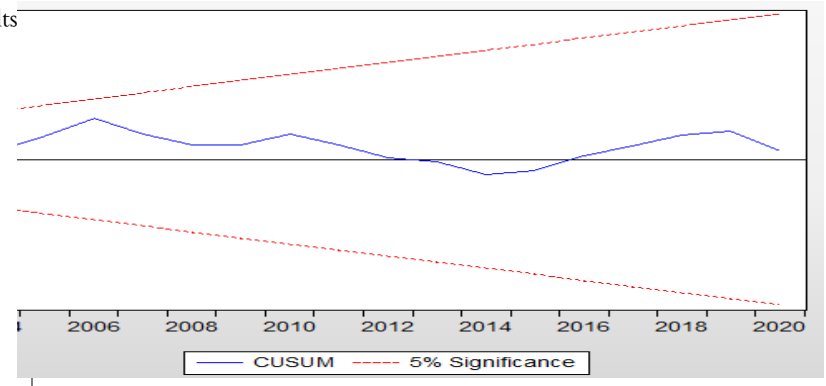
atistic	0.791524	Prob. F(1,34)	0.3799
*R-squared	0.819017	Prob. Chi-Square(1)	0.3655

Normality test Jarque-Bera:



Model stability *Plot of cumulative sum of the recursive residuals*

test results



Plot of cumulative sum of squares of recursive residuals-squared

Source: Prepared by the researchers based on Eviews 10 Program