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"An Integrated Model for Adopting Renewable Energy in IRAQ: A Standard Study for the Period (1992-2023)"

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Abstract

Data related to the study variables were collected for the period from 1992 to 2023, with the sample size reaching 31 observations for each variable. This research aims to review and analyze descriptive data for these multiple variables, which are related to different areas of renewable energy use and electricity consumption in Iraq. This research addresses important variables, including renewable energy, government policies related to it, and the level of public awareness of the subject. In addition, other variables such as electricity consumption, country's population, volume of imports and exports, economic growth, technological innovation, and foreign direct investment flows are analysed. The importance of this research is to understand the trends and factors influencing the field of renewable energy in Iraq, which can contribute to developing effective policies to promote the use of renewable energy and achieve environmental and economic sustainability in the country. Considering the negative impact, the variables EC (electricity consumption), NPG (population) and GP (economic growth) seem to have a negative impact on renewable energy production in the long run. Increased electrical consumption and population and economic growth can lead to increased demand for traditional sources of energy, reducing environmental sustainability and exposing the country to negative consequences in the future. On the other hand, the positive effect of the variables EG (economic growth), FDIF (foreign direct investment inflows), I (imports), PA (exports) and TI (technological innovation) on renewable energy production is shown. Increased investment in renewable energy infrastructure and adoption of clean technology can contribute to achieving environmental sustainability and boosting the economy. Using EViews 12 software, these variables will be analyzed according to available data with the aim of understanding trends, challenges and opportunities related to renewable energy in Iraq.

Keywords: *Renewable Energy, Government Policies, Public Awareness, Electricity Consumption, Country Population, Volume of Imports and Exports, Economic Growth, Technological Innovation, Foreign Direct Investment Flows, EViews 12.*

INTRODUCTION

Relying on renewable energy and achieving environmental and economic sustainability in energy use are among the most important challenges facing Iraq and many countries at the present time. Therefore, the importance of this research comes in analyzing the factors affecting the field of renewable energy in Iraq, which can contribute to directing policies and strategies to enhance the use of renewable energy and achieve environmental and economic sustainability. This study aims to review and analyze descriptive data for a variety of variables related to the field of renewable energy use and electricity consumption in Iraq during the period from 1992 to 2023. Among the variables studied, the focus is on government policies related to energy, the level of public awareness of renewable energy issues, In addition to other variables such as electricity consumption, the country's population, the volume of imports and exports, economic growth, technological innovation, and foreign direct investment flows. By analyzing these variables, the focus is on identifying trends, challenges, and opportunities facing the renewable energy sector in Iraq. The negative impact of some variables, such as electricity consumption, the country's population, and economic growth, is of particular concern, as it could negatively affect renewable energy production and expose the country to environmental and economic challenges in the future. While the positive impact of some variables such as economic growth, foreign direct investment flows, and technological innovation appears, which indicates the importance of enhancing these factors to achieve environmental and economic sustainability. EViews 12 will be used to analyze data and understand trends, challenges and opportunities related to renewable energy in Iraq. It is expected that the results of this study will contribute to developing effective policies to promote the

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use of renewable energy and achieve environmental and economic sustainability in Iraq. (Viet Duc Bui et al.2023).

The limits of the Study

Temporal limits : The study was applied in the academic years : 1992-2023

Terminology of Study

Renewable energy: It is energy that is extracted from renewable natural sources such as sun, wind, water, and geothermal heat. This energy is used to generate electricity, heat homes, or operate cars, and it is considered an environmentally friendly alternative to fossil fuels. (Yinghao Zhou.2018)

Government policies : These are the actions and legislation taken by governments to direct economic, social and environmental policies. Government policies aim to achieve certain goals such as promoting economic growth, achieving sustainability, and improving the quality of life. (Muhammad Badar Hayat et al.2018)

Public awareness : refers to the extent of the public's understanding and awareness of certain issues, whether environmental, social, or economic. Public awareness is important to achieve change and improvement in society. (Mikhail Nikolaevich et al.2019)

Electricity consumption : It expresses the amount of electrical energy consumed by consumers, whether in homes, industries, or services. Electricity consumption is usually measured in watts or kilowatt-hours. (Murat Kankal et al.2019)

Country population : represents the number of people living in a particular country at a particular time. Population is an important factor in determining a country's resource needs and planning government policies. (Javier Sánchez.2019)

Imports and Exports : Imports refer to the goods and services that a particular country imports from abroad, while exports refer to the goods and services that the country sells to foreign markets. (Sarkodie SA, Strezov V.2019)

Economic growth : refers to the increase in a country's economic production during a certain period of time. Economic growth is usually measured by the percentage increase in a country's gross domestic product. (Shehzad Yu et al.2019)

Technological innovation : refers to the process of developing and adopting new technology or improving existing technology to improve processes and products or develop new solutions to problems. (Viet Duc Bui et al.2023)

Foreign direct investment flows : represent investments made by individuals or companies from a particular country in other economies, which affect the economic growth and technological development of the two countries. (. Merlin Raud et al.2019)

Study Population and Sample

Data was collected about the study variables for the period (1992 - 2023) and to conduct a descriptive analysis of those variables, as the sample size reached 31 observations for each of the study variables. Therefore, this element was allocated to review the data related to the study variables by presenting the descriptive data analysis below. EViews 12 has been approved.

Study Variables

Y= (RE) Renewable energy

X1= (GP) Government Policies

X2= (PA) Public Awareness

X3= (EC) Electricity consumption

X4 = (NPG) Country population Imports

X5= (I) Imports

X6= (E) Exports

X7= (EG) Economic growth

X8= (TI)Technological innovation

X9= (FDIF) Foreign direct investment inflows

$$RE=f(GP, PA, EC, NPG, I, E, EG, TI, FDIF)$$

RESULTS OF ESTIMATORS OF DESCRIPTIVE ANALYSIS OF VARIABLES

Table 1 : Results of descriptive analysis estimators of variables

	E	EC	EG	FDIF	GP	I	NPG	PA	RE	TI
Mean	0.394479	1.192577	1.468981	0.271176	0.925967	0.781019	3.128405	1.705393	9.161296	3.376612
Median	0.509329	1.306127	1.629455	0.673841	0.924584	0.000000	4.176258	2.010048	9.176469	4.265536
Maximum	0.940685	1.798651	1.856729	1.040234	1.041945	1.961229	4.517122	2.066751	9.438848	4.945806
Minimum	-1.250635	-0.308295	0.439450	-3.589115	0.757647	0.000000	0.000000	-0.553694	8.447313	0.000000
Std. Dev.	0.549282	0.563869	0.392892	1.050652	0.073757	0.911380	1.874181	0.720971	0.195215	1.853182
Skewness	-1.313914	-1.145360	-1.245988	-2.406435	-0.412885	0.320210	-1.031232	-2.314550	-1.425890	-1.223520
Kurtosis	4.410506	3.685654	3.351433	8.317743	2.893518	1.172383	2.196870	6.999336	7.010088	2.682034
Jarque-Bera	1.86001	1.623364	1.444596	1.58948	0.924312	1.000430	1.531703	1.89768	1.28460	1.118810
Probability	0.002658	0.022111	0.014665	0.000000	0.629924	0.082067	0.038164	0.000000	0.000000	0.017259
Sum	12.62332	38.16245	47.00739	8.677619	29.63095	24.99262	100.1090	54.57256	293.1615	108.0516
Sum Sq. Dev.	9.353030	9.856407	4.785290	34.21994	0.168642	25.74903	108.8891	16.11377	1.181377	106.4628
Observations	32	32	32	32	32	32	32	32	32	32

Source : Prepared by the student based on the outputs of the EViews 12 program

The arithmetic mean Mean Renewable Energy Y= (RE) in Iraq during the study period was 9.161296. It recorded its largest value of 9.438848 and the lowest value was estimated at 8.447313. We notice small differences in the values, and we note from the value of the standard deviation Std.Dev that the value is somewhat high. As for the indicator variable (TI) and the indicator variable (NPG), this indicates that there is no homogeneity for the variables. It is noted that the variables do not follow a normal distribution, as the significance value (probability) was greater than 0.05 for the JarqueBera test value.

Time Series Stability Analysis

To study the stability of time series of variables, we use two tests : the Extended Dickey-Fuller test (ADF) and the Philippe-Perron PP test, with the addition of the logarithm for better stability of the model. The stability results were as follows :

Table 2 : Time series stability analysis

UNIT ROOT TEST TABLE (PP)

		At Level									
		RE	E	EC	EG	FDIF	GP	I	NPG	PA	TI
With Constant	t-Statistic	-4.6791	-1.7098	-3.2816	-3.8843	-2.0343	-2.5364	-2.0636	-1.7046	-6.4871	-1.8802
	Prob.	*0.0007*	*0.4166*	*0.0246*	*0.0058*	*0.2714*	*0.1170*	*0.2599*	*0.4191*	*0.0000*	*0.3368*
		***	n0	**	***	n0	n0	n0	n0	***	n0
With Constant & Trend	t-Statistic	-4.5087	-2.1518	-1.0809	-1.3107	-2.7871	-1.7029	-2.0982	-1.0541	-3.7655	-1.1575
	Prob.	*0.0059*	*0.4983*	*0.9163*	*0.8664*	*0.2122*	*0.7258*	*0.5266*	*0.9209*	*0.0325*	*0.9019*
		***	n0	n0	n0	n0	n0	n0	n0	**	n0
Without Constant & Trend	t-Statistic	1.0270	-1.2566	-0.2254	0.6645	-1.9709	0.2006	-1.5086	-0.0300	-0.0629	0.0115
	Prob.	*0.9161*	*0.1876*	*0.5969*	*0.8543*	*0.0480*	*0.7378*	*0.1210*	*0.6651*	*0.6540*	*0.6788*
		n0	n0	n0	n0	**	n0	n0	n0	n0	n0
		At First Difference									
		d(RE)	d(E)	d(EC)	d(EG)	d(FDIF)	d(GP)	d(I)	d(NPG)	d(PA)	d(TI)
With Constant	t-Statistic	-8.4747	-5.5862	-4.8562	-5.0141	-6.1090	-3.8420	-4.8633	-4.8458	-2.1779	-5.2216
	Prob.	*0.0000*	*0.0001*	*0.0005*	*0.0003*	*0.0000*	*0.0066*	*0.0005*	*0.0005*	*0.0000*	*0.0002*
		***	***	***	***	***	***	***	***	***	***
With Constant & Trend	t-Statistic	-8.1786	-5.5648	-6.2444	-6.7649	-5.9697	-4.0592	-4.8910	-5.0567	-3.5287	-5.6592
	Prob.	*0.0000*	*0.0005*	*0.0001*	*0.0000*	*0.0002*	*0.0173*	*0.0024*	*0.0016*	*0.0543*	*0.0004*
		***	***	***	***	***	**	***	***	*	***
Without Constant & Trend	t-Statistic	-8.5129	-5.6667	-4.7753	-4.8089	-6.0798	-3.9293	-4.9626	-4.7615	-1.8466	-5.1262
	Prob.	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0003*	*0.0000*	*0.0000*	*0.0625*	*0.0000*
		***	***	***	***	***	***	***	***	*	***

UNIT ROOT TEST TABLE (ADF)

		At Level									
		RE	E	EC	EG	FDIF	GP	I	NPG	PA	TI
With Constant	t-Statistic	-2.7970	-1.7098	-3.1457	-3.5174	-2.0143	-2.8605	-1.9357	-1.7046	-6.4871	-1.8802
	Prob.	*0.0715*	*0.4166*	*0.0334*	*0.0142*	*0.2795*	*0.0621*	*0.3124*	*0.4191*	*0.0000*	*0.3368*
		*	n0	**	**	n0	*	n0	n0	***	n0
With Constant & Trend	t-Statistic	-2.7424	-2.0411	-1.3565	-1.4878	-2.7035	-2.5747	-1.8254	-1.0541	-11.7956	-1.1571
	Prob.	*0.2286*	*0.5568*	*0.8538*	*0.8122*	*0.2421*	*0.2934*	*0.6679*	*0.9209*	*0.0000*	*0.9020*
		n0	n0	n0	n0	n0	n0	n0	n0	***	n0
Without Constant & Trend	t-Statistic	1.0270	-1.2566	-0.1100	0.8877	-1.9411	0.2490	-1.4261	0.0399	-0.4606	0.0610
	Prob.	*0.9161*	*0.1876*	*0.6378*	*0.8953*	*0.0512*	*0.7519*	*0.1404*	*0.6880*	*0.5068*	*0.6948*
		n0	n0	n0	n0	*	n0	n0	n0	n0	n0
		At First Difference									
		d(RE)	d(E)	d(EC)	d(EG)	d(FDIF)	d(GP)	d(I)	d(NPG)	d(PA)	d(TI)
With Constant	t-Statistic	-8.1807	-5.5531	-4.8630	-5.0181	-6.6815	-3.8289	-4.8950	-4.8458	-3.1796	-5.2216
	Prob.	*0.0000*	*0.0001*	*0.0005*	*0.0003*	*0.0001*	*0.0068*	*0.0004*	*0.0005*	*0.0317*	*0.0002*
		***	***	***	***	***	***	***	***	**	***
With Constant & Trend	t-Statistic	-2.1477	-5.4927	-6.1970	-6.4242	-5.5787	-4.1025	-4.9184	-5.0844	-3.0427	-5.5841
	Prob.	*0.4985*	*0.0005*	*0.0001*	*0.0001*	*0.0004*	*0.0156*	*0.0023*	*0.0015*	*0.1380*	*0.0004*
		n0	***	***	***	***	**	***	***	n0	***
Without Constant & Trend	t-Statistic	-8.2458	-5.6445	-4.7807	-4.8023	-5.7789	-3.9172	-4.9817	-4.7621	-3.6498	-5.1189
	Prob.	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0000*	*0.0003*	*0.0000*	*0.0000*	*0.0007*	*0.0000*
		***	***	***	***	***	***	***	***	***	***

Notes : (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1%. and (no) Not Significant
*MacKinnon (1996) one-sided p-values.

Source : Prepared by the student based on the outputs of the EViews 12 program

We adopt unit root tests for time series of variables in the model. The use of ADF (Philippe-Peron's) PP tests and their results are shown in the table, where it is noted that the RE level (for certain series is stable, and others are stable only when the difference on them occurs to the first. System: We are faced with the option of applying the Autoregressive Distributed Time lapse ARDL model, so this test It does not require integration of the studied variables to the same degree, and this is what distinguishes it. As Pesaran believes, we can apply the bounds test according to the ARDL methodology without looking at the characteristics of the time series, whether these variables are stable in their first-order differences (I1), or stable in their levels. (0I) or a combination of both. These variables are not stable with respect to quadratic differences; this is the only condition in applying this test.

Relationship Modeling

After analyzing the indicator variables used in the standard study, and determining the degree of integration of the time series, all of which stabilized at the first difference, the results of estimating the cointegration

model according to the ARDL methodology will be presented below, where the model is estimated as follows :

$$RE=f\,(GP,PA,EC,NPG,I,E,EG,TI,FDIF)$$

$$RE_t = f(GP_t + PA_t + EC_t + NPG_t + I_t + E_t + EG_t + TI_t + FDIF_t)$$

Unconstrained error model estimation and selection of optimal lag periods for model variables

Through the study, we attempted to change the modified automatic deceleration periods resulting from estimating the ARDL-ECM error correction model using the Ordinary Least Squares (OLS) method. The results are shown in the following table :

Table 3 : Testing lag periods representative of the selected and estimated models

Optimal delay periods ($p \cdot q_1$)	Delay periods used		Model
AIC	q_1	p_1	
(1.1.1.1.1.1.1.1.)	1	4	

Source : Prepared by the student based on the outputs of the EViews 12 program

After determining the lag periods for all models, as shown in the table, which were chosen according to the AIC criterion, and to ensure the existence of a long-term relationship, we use the bounds test, as well as the quality of the most appropriate estimated model after subjecting it to diagnostic tests.

Bounds Test

To detect the existence of a long-term relationship between variables, the bound test must be used, by comparing the F value calculated for the coefficients of the slowed independent variables with the value of the critical F statistic, according to the limits set by Pesaran and al.

The test is carried out based on the null hypothesis, which states : There is no long-term equilibrium relationship between the variables.

Table 4: Bounds test results for the models

The result	f.stat	k						Model
			10%	5%	2.5%	1%	Critical values	
A significance of less than 1% means a long-term relationship	7.440291	1	3.2	3.67	4.08	4.66	upper limits	**Model equation**

Source : Prepared by the student based on the outputs of the EViews 12 program

After determining the results of the bounds test for the models as shown in a table, the Fisher f-stat for the models was estimated at 7.440291, which exceeds the upper limits at 1% significance set by Peasaran, up to the value of 10%, leading to the rejection of the null hypothesis that there is no relationship. The long-term approach goes from the explanatory variables to the dependent variables and accepts the alternative hypothesis, which states that there is a long-term relationship. Thus, one can choose co-integration for the long-term equilibrium relationship for all models.

Model Estimation Results

After ensuring the existence of a long-term equilibrium relationship between variables in the model that we included in this study, the results of cointegration and the short-term relationship and the form of the long-term relationship are estimated below:

Through the results presented in the table for estimating ARDL in the short term, which appears in the upper part of the table, while the lower part shows the estimation of the long-term relationship through the estimated model, an interpretation of it in the long and short term will be presented as follows :

Model Estimation

Table 5 : Model estimate number

Dependent Variable : RE
Method : ARDL
Date : 03/12/24 Time : 13:26
Sample (adjusted) : 1993 2023
Included observations : 31 after adjustments
Maximum dependent lags : 3 (Automatic selection)
Model selection method : Akaike info criterion (AIC)
Dynamic regressors (1 lag, automatic) : GP PA EC NPG I E EG TI FDIF
Fixed regressors : C
Number of models evaluated : 1536
Selected Model : ARDL (1, 1, 1, 1, 1, 1, 1, 1, 1, 1)
Note : final equation sample is larger than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
RE (-1)	0.484005	0.178023	2.718785	0.0200
GP	-4.440120	0.720836	-6.159682	0.0001
GP (-1)	-1.828619	0.582456	-3.139498	0.0094
PA	2.881472	0.414739	6.947671	0.0000
PA (-1)	-2.450102	0.465604	-5.262205	0.0003
EC	1.756945	0.382783	4.589929	0.0008
EC (-1)	-2.151729	0.245015	-8.782030	0.0000
NPG	-0.779311	0.112443	-6.930739	0.0000
NPG (-1)	-0.292327	0.048650	-6.008771	0.0001
I	-0.100154	0.047994	-2.086803	0.0610
I (-1)	0.295559	0.028400	10.40702	0.0000
E	-0.804715	0.181575	-4.431873	0.0010
E (-1)	0.694475	0.104834	6.624526	0.0000
EG	0.020032	0.392760	0.051002	0.9602
EG (-1)	0.994199	0.268651	3.700706	0.0035
TI	-0.057352	0.019786	-2.898552	0.0145
TI (-1)	0.794507	0.100309	7.920568	0.0000
FDIF	0.716149	0.114602	6.249023	0.0001
FDIF (-1)	0.323752	0.063283	5.115957	0.0003
C	9.093600	0.925086	9.830006	0.0000

R-squared	0.993601	Mean dependent var	9.184328
Adjusted R-squared	0.982549	S.D. dependent var	0.147779
S.E. of regression	0.019522	Akaike info criterion	-4.780313
Sum squared resid	0.004192	Schwarz criterion	-3.855160
Log likelihood	94.09485	Hannan-Quinn criter.	-4.478736
F-statistic	89.89918	Durbin-Watson stat	3.090139
Prob (F-statistic)	0.000000		

*Note : p-values and any subsequent tests do not account for model selection.

Source : Prepared by the student based on the outputs of the EViews 12 program

R-Squared (Correlation Square)

• This measure indicates how much of the response of the dependent variable (renewable energy) can be explained by the independent variables used in the model. In this case, the R-squared is 0.993601, which means that 99.36% of the variance in renewable energy can be explained by the independent variables in the model.

Adjusted R-squared

• This measure indicates how much of the dependent variable response can be explained by the independent variables after adjusting for the number of samples and the number of variables in the model. Adjusted R-squared is 0.982549.

S.E. of Regression

• This measure measures the average standard errors of the typical predictions from the model. S.E. of regression is estimated at 0.019522.

F-statistic (Difference Test)

• This test is used to determine whether there is a general statistical relationship between the independent variables and the dependent variable. In this case, the value of the F-statistic is estimated at 89.89918, and the probability value (Prob(F-statistic)) showed that the hypothesis is strongly rejected with a value close to zero.

Prob(F-Statistic) (Probability Of Difference)

• This value provides the probability of a statistical relationship between the independent variables and the dependent variable. In this case, the value of Prob(F-statistic) is close to zero, indicating a strong statistical relationship.

Top 20 Models

The following figure also shows the appropriate model:

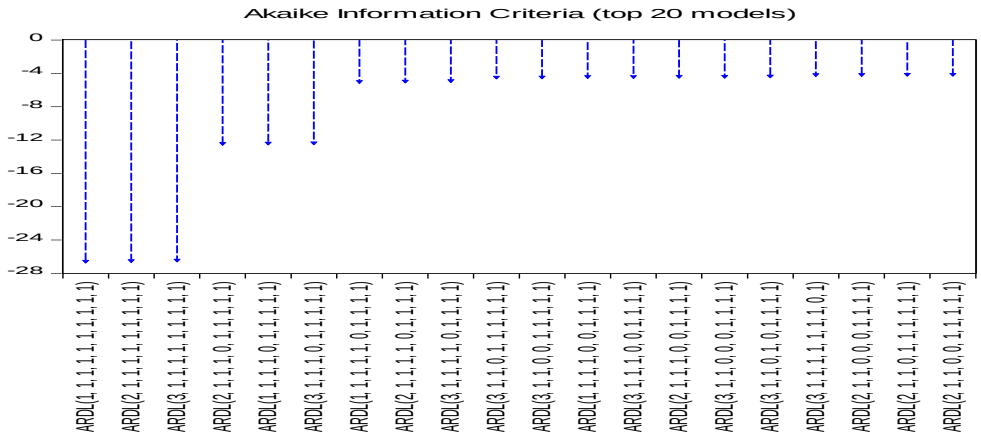


Figure 1: Akaike information criteria (top 20 models)

Source : Prepared by the student based on the outputs of the EViews 12 program

Model Quality Detection

Within the framework of estimation using the ordinary least squares method, which requires that the model errors follow a normal distribution, otherwise they are biased and that they are independent and have the least variance. It is assumed that the model estimated according to the ARDL methodology meets the assumptions of this method by conducting a set of diagnostic tests, which are three tests. :

1- Normality test for normal distribution of random errors

2- Testing the lack of autocorrelation between errors

3- Homocedqsticity test

The results were as follows

Table 6 summarizes the detection results of the estimated model quality

ARCH	BG LM	JB	Tests

F=1.759097 (0.1963)	F=0.264929 (0.7702)	x^2=0.578832 (0.748701)	**Test results for the study model**

Source : Prepared by the student based on the outputs of the EViews 12 program

After determining the quality results of the estimated models in the table, the following appears:

The Jarque-Berra statistic was greater than 0.05 for the entire study model, which means that the residuals follow a normal distribution.

- The P-value statistic for the BG LM test says that the f-value statistic is greater than 0.05, and from this we accept the null hypothesis : that there is no serial autocorrelation of the residuals for the model.

- The ARCH test shows that the probability value of the F statistic is greater than the critical value at a significance level of 0.05, so we accept the null hypothesis, that is, the variance is constant for all of the model.

The results of the diagnostic tests show the goodness of the model in standard terms, so the cointegration model will be estimated in both terms.

Testing the Structural Stability of the Model Coefficients

To ensure that the data used are free of any structural change, Peearan conducted two tests to test the structural stability of the model coefficients in the short and long term. The first test represents the selection of the cumulative group of the recursive residuals (CUSUM), while the second test is the cumulative group test of the squares of the recursive residuals (CUSUM). of Squares, where structural stability of the estimated coefficients of the ARDL model is achieved if the graph of the tests for both CUSUM of Squares and CUSUM falls within the critical limits at the 5% level of significance, we thus reject the null hypothesis: the parameters are unstable and we accept the alternative hypothesis of their stability during the study period.

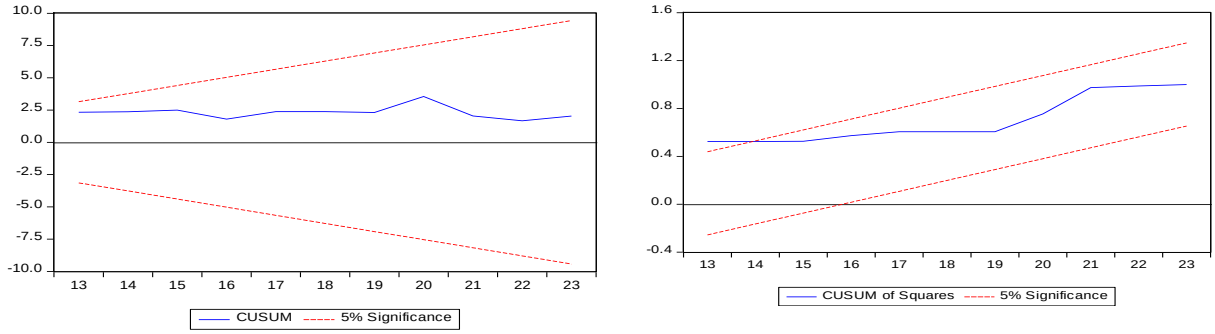


Figure 2 The recursive cumulative group test for both the residuals and the squares of the residuals for the model

Source : Prepared by the student based on the outputs of the EViews 12 program

We have shown, through the graphs shown above, that the cumulative set of the recursive residuals (CUSUM of Squared) lies within the critical region for the model, which confirms the stability of the model at the 5% significance level. The same applies to the cumulative set of squares of the recursive residuals (CUSUM of Squared), and from it it can be said that there is Consistency and stability between the long-term results and the short-term results of the estimated model.

Test for Autocorrelation Between Errors

In this test, we will rely on Darbin-Watson (DW) statistics, as we have from the estimation table the value of the statistic equal to 2.09, meaning that it falls in the region of no autocorrelation between errors.

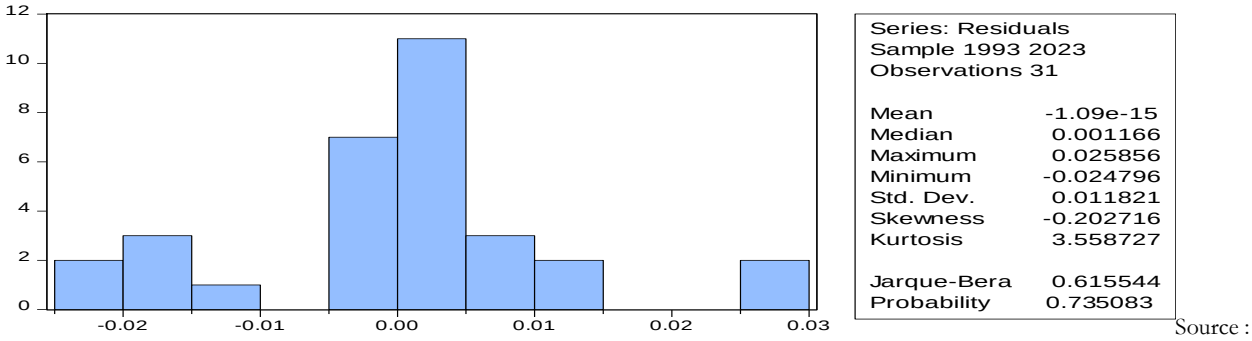
Jarque-Bera Test

This test is based on the following two hypotheses:

H_0 follows a normal distribution

H_1 does not follow a normal distribution

Figure 3 Test of normal distribution of the estimated residuals



Source : Prepared by the student based on the outputs of the EViews 12 program

From the figure above it is clear that the residuals follow a normal distribution, because the J-B statistic reached 0.615, which is completely less than the critical value of the χ_(2(0.05))^2 distribution, in addition to that the corresponding probability is greater than 0.05, which means rejecting the hypothesis. Zero.

The characteristic polynomial root of the study model

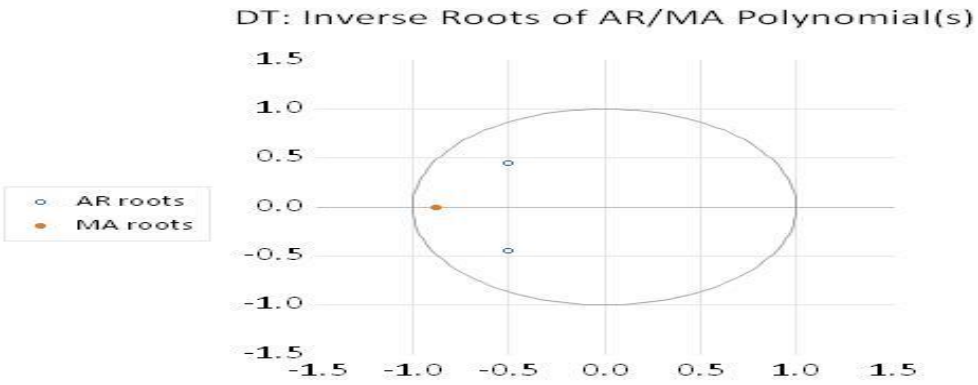


Figure 4 Root of the characteristic polynomial of the study model

Source : Prepared by the student based on the outputs of the EViews 12 program

From the figure above, we notice that the root of the characteristic polynomial of the model lies within the unary circle, which indicates the stability of the model process.

ARDL long run model and bounds testing

Table 7 ARDL long-run model and bounds testing

ARDL Long Run Form and Bounds Test
Dependent Variable : D(RE)
Selected Model : ARDL (1, 1, 1, 1, 1, 1, 1, 1, 1, 1)
Case 2 : Restricted Constant and No Trend
Date : 03/12/24 Time : 13:48
Sample : 1992 2023
Included observations : 31

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.093600	0.925086	9.830006	0.0000
RE (-1)*	-0.515995	0.178023	-2.898477	0.0000
E (-1)	-0.110241	0.133850	-0.823614	0.0277
EC (-1)	-0.394784	0.374609	-1.053856	0.0145
EG (-1)	1.014230	0.482160	2.103514	0.0092
FDIF (-1)	1.039901	0.167285	6.216328	0.0001
GP (-1)	-6.268739	1.255568	-4.992750	0.0004
I (-1)	0.195406	0.042776	4.568075	0.0008
NPG (-1)	-1.071639	0.157024	-6.824676	0.0000
PA (-1)	0.431370	0.194386	2.219142	0.0484
TI (-1)	0.737155	0.092323	7.984492	0.0000
D(E)	-0.804715	0.181575	-4.431873	0.0010
D(EC)	1.756945	0.382783	4.589929	0.0008
D(EG)	0.020032	0.392760	0.051002	0.9602
D(FDIF)	0.716149	0.114602	6.249023	0.0001
D(GP)	-4.440120	0.720836	-6.159682	0.0001
D(I)	-0.100154	0.047994	-2.086803	0.0610
D(NPG)	-0.779311	0.112443	-6.930739	0.0000
D(PA)	2.881472	0.414739	6.947671	0.0000
D(TI)	-0.057352	0.019786	-2.898552	0.0145

* p-value incompatible with t-Bounds distribution.

Levels Equation

Case 2 : Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
E	-0.213647	0.307140	-0.695602	0.0011
EC	-0.765093	0.483741	-1.581618	0.0420
EG	1.965583	1.287582	1.526569	0.0051
FDIF	2.015333	0.958785	2.101965	0.0094
GP	-12.14885	6.316632	-1.923311	0.0007
I	0.378697	0.096857	3.909863	0.0024
NPG	-2.076841	0.967636	-2.146304	0.0050
PA	0.835998	0.183191	4.563541	0.0008
TI	1.428609	0.624051	2.289249	0.0428
C	17.62344	4.532788	3.887992	0.0025

EC = RE - (-0.2136*E -0.7651*EC + 1.9656*EG + 2.0153*FDIF -12.1488*GP
+ 0.3787*I -2.0768*NPG + 0.8360*PA + 1.4286*TI + 17.6234)

Source : Prepared by the student based on the outputs of the EViews 12 program

$$(RE)_t = (-0.2136*(E)_t - 0.7651*(EC)_t + 1.9656*(EG)_t + 2.0153*(FDIF)_t - 12.1488*(GP)_t + 0.3787*(I)_t - 2.0768*(NPG)_t + 0.8360*(PA)_t + 1.4286*(TI)_t + 17.6234 + \varepsilon_t)$$

We note from the table above that the value of γ was negative (0.515995) and significant with a value estimated at (0.0000), which is less than 0.05. This indicates that the long-term model corrects the errors of the short-term model in a period of approximately less than two years.

Analysis Of Long-Term Estimation Results

The following is evident from the bottom of the table

The variable E has negatively affected the dependent variable RE in the long term and has a very acceptable significance at 0.11% (0.0011), which is less than 5%, as a 1% increase leads to a decrease in RE by 0.21%.

The EC variable has a negative impact on the dependent variable EG in the long term and has acceptable significance at 0.51% (0.0051), which is less than 10%, as a 1% increase leads to a decrease in RE of 0.76%.

The EG variable has a positive effect on the dependent variable RE in the long term and has a very acceptable significance at 0.15% (0.0051), which is less than 5%, as a 1% increase leads to an increase in RE by 1.96%.

The FDIF variable has a positive effect on the dependent variable RE in the long term and has a very acceptable significance at 0.94% (0.0094), which is less than 5%, as a 1% increase leads to an increase in RE by 2.01%.

The GP variable had a negative impact on the dependent variable RE in the long term and has a very acceptable significance at 0.07% (0.0007), which is less than 1%, as a 1% increase leads to a decrease in RE of 12.14%.

The I variable has a positive effect on the dependent variable RE in the long term and has a very acceptable significance at 0.24% (0.0024), which is less than 1%, as a 1% increase leads to an increase in RE by 0.37%.

The NPG variable had a negative impact on the dependent variable RE in the long term and has a very acceptable significance at 0.5% (0.0050), which is less than 1%, as an increase of 1% leads to a decrease in RE of 2.07%.

The PA variable has a positive effect on the dependent variable RE in the long term and has acceptable significance at 0.08% (0.0008), which is less than 1%, as a 1% increase leads to an increase in RE by 0.83%.

The TI variable has a positive effect on the dependent variable RE in the long term and has a very acceptable significance at 4.28% (0.0428), which is less than 5%, as a 1% increase leads to an increase in RE by 1.42%.

Analysis Of Short-Term Estimation Results

The upper part of the table shows the following :

The variable E has negatively affected the dependent variable RE in the long term and has a very acceptable significance at 2.77% (0.0277), which is less than 5%, as an increase of 1% leads to a decrease in RE of 0.11%.

The EC variable had a negative impact on the dependent variable EG in the long term and has acceptable significance at 1.45% (0.0145), which is less than 10%, as a 1% increase leads to a decrease in RE of 0.39%.

The EG variable has a positive effect on the dependent variable RE in the long term and has a very acceptable significance at 0.92% (0.0092), which is less than 5%, as an increase of 1% leads to an increase in RE of 1.01%.

The FDIF variable has a positive impact on the dependent variable RE in the long term and is highly significant at 0.01% (0.0001), which is less than 5%, as a 1% increase leads to an increase in RE of 1.4%.

The GP variable had a negative impact on the dependent variable RE in the long term and has a very acceptable significance at 0.04% (0.0004), which is less than 1%, as a 1% increase leads to a decrease in RE of 6.26%.

The I variable has a positive impact on the dependent variable RE in the long term and has a very acceptable significance at 0.08% (0.0008), which is less than 1%, as a 1% increase leads to an increase in RE by 0.19%.

The NPG variable had a negative impact on the dependent variable RE in the long term and has a very acceptable significance at 0.0% (0.0000), which is less than 1%, as an increase of 1% leads to a decrease in RE of 1.07%.

The PA variable has a positive effect on the dependent variable RE in the long term and has acceptable significance at 0.48% (0.0484), which is less than 5%, as a 1% increase leads to an increase in RE by 0.43%.

The variable TI has a positive impact on the dependent variable RE in the long term and is highly significant at 0.00% (0.0000), which is less than 1%, as a 1% increase leads to an increase in RE by 0.73%.

RESULTS

Analysis of the results of long- and short-term estimation reveals several important observations related to the impact of variables on renewable energy (RE) production in Iraq.

In the long run, variables such as electricity consumption (EC), population (NPG) and economic growth (GP) appear to have a negative impact on renewable energy production, while variables such as economic growth (EG), foreign direct investment inflows (FDIF) and imports (I), exports (PA) and technological innovation (TI) positively affect renewable energy production. These results indicate the importance of adopting policies that promote sustainable economic growth, encourage renewable energy investments, and promote clean technologies.

In the short term, variables such as electricity consumption (EC) and economic growth (EG) continue to have a negative impact on renewable energy production, indicating the need for immediate action to improve energy efficiency and encourage the use of alternative technologies to reduce dependence on traditional sources of energy.

Considering the negative impact, the variables EC (electricity consumption), NPG (population) and GP (economic growth) seem to have a negative impact on renewable energy production in the long run. Increased electrical consumption and population and economic growth can lead to increased demand for traditional sources of energy, reducing environmental sustainability and exposing the country to negative consequences in the future.

On the other hand, the positive effect of the variables EG (economic growth), FDIF (foreign direct investment inflows), I (imports), PA (exports) and TI (technological innovation) on renewable energy production is shown. Increased investment in renewable energy infrastructure and adoption of clean technology can contribute to achieving environmental sustainability and boosting the economy.

Recommendations

To achieve energy and economic sustainability, the Iraqi government should take the following actions :

Encouraging investment in renewable energy : The government must develop supportive policies that encourage investment in the development and implementation of renewable energy projects, including providing financial incentives and ensuring legal and tax stability for investors.

Improving the efficiency of energy consumption : The government should enhance efforts to improve the efficiency of energy consumption by implementing policies that encourage the efficient use of energy and the adoption of clean technology in various economic sectors.

Strengthening international cooperation : Iraq can benefit from cooperation with international companies and organizations with experience in the field of renewable energy to transfer technology and develop local capabilities, as well as to learn about best practices and successful experiences in this field.

Promoting research and development : The government should enhance investment in research and development in renewable energy to develop innovative and effective solutions that meet future energy needs and enhance the country's economic competitiveness.

Coordination with oil companies operating in Iraq within oil licensing rounds to support sustainable environmental development and benefit from their expertise in providing renewable energy to reduce consumption of electrical energy.

Supporting employees with loans from banks in the country to purchase solar energy systems

By implementing these recommendations, Iraq can achieve a positive transition towards energy sustainability and economic and social development in the future. In addition, the positive impact of proven variables on renewable energy production underscores the importance of taking actions to support these factors, such as strengthening international cooperation for technology transfer and increasing investment in renewable energy research and development.

Overall, these analytical results require the adoption of multi-level policies aimed at enhancing environmental sustainability and achieving economic goals in the energy sector in Iraq.

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