Economic and econometric analysis of the impact of green economy indicators on agricultural development in Iraq for the period 2004-2025

Ali A. Fadhel[1] Mohamad K. Abdallah[2]

[1,2]Department of Economics and Agricultural Extension, College of Agriculture, University of Tikrit, Republic of Iraq.

Corresponding author: E-mail: [2,] AAFpagr54@st.tu.edu.iq

Abstract

This study aimed to measure and analyze the economic and econometric impact of green economy indicators on agricultural development in Iraq during the period 2004–2025 using semi-annual time series data, focusing on the role of environmental economics and water resource variables. The study employed an econometric analytical approach using the Autoregressive Distributed Limits (ARDL) model, boundary testing to examine long-run cointegration relationships, and the Error Correction Model (ECM) to analyze short-run dynamics. The empirical results revealed a long-run cointegration relationship among the variables. Gross domestic product (GDP) showed a negative impact on agricultural production due to the Dutch Disease phenomenon and the dominance of the oil rentier sector. Conversely, green GDP, environmental allocations, and water flows from the Tigris and Euphrates rivers demonstrated significant positive impacts on enhancing the long-term sustainability and productivity of agriculture, while agricultural investment allocations showed negative coefficients due to structural imbalances and project management problems. Furthermore, the error correction coefficient indicated that short-term shocks return to equilibrium at an annual rate of 0.23. Based on these findings, the study recommends formulating a national water security strategy, modernizing irrigation systems, and integrating green economy policies and accounts into development plans to support the agricultural sector in Iraq.

Keywords: Green, Economy , ARDL, Water, Iraq.

Introduction

The green economy is an emerging concept based on reshaping economic and developmental relationships to achieve sustainable development without harming the natural environment [1]. It is considered an influential approach in light of the growing climate challenges facing the world today, such as climate change and the depletion of natural resources [2]. With the development of societies and the increase in population, the need for a sustainable economic model has become more urgent than ever [3]. The green economy is embodied in a set of economic practices and policies that focus on improving the efficiency of resource utilization, reducing harmful emissions, and promoting innovation in green technologies, while maintaining social justice. In the current context, the green economy is a fundamental pillar for achieving the sustainable development goals set by the United Nations in its 2030 Agenda. Sustainable development focuses on achieving a balance between economic development, environmental sustainability, and a decent social life, which requires adopting economic strategies that ensure the continuity of natural resources for future generations [4]. This is where the

ISSN 2072-3857

green economy plays a role as an effective mechanism for achieving this balance, by restructuring economic activities to be less carbon-intensive and more environmentally friendly [5]. This highlights the importance of the green economy through its direct impact on diverse economic activities such as energy, agriculture, industry, and transportation. In the energy sector, the shift towards renewable energy sources like solar and wind power contributes to reducing reliance on fossil fuels and, consequently, lowering carbon emissions. In agriculture, the green economy focuses on developing sustainable farming methods that preserve soil. In the industrial sector, the emphasis is on improving production efficiency and minimizing industrial waste through the adoption of environmentally friendly technologies [6].

The green economy also contributes to creating new job opportunities and stimulating innovation, thus enhancing societies' ability to effectively manage environmental and economic changes. Adopting new technologies and improving resource efficiency not only protects the environment but also opens new economic horizons and creates opportunities for sustainable growth. For example, the transition to a green economy leads to the growth of sectors involved in waste recycling, clean energy production, and organic farming, contributing to reduced unemployment and enhanced economic development. However, the green economy still faces numerous challenges that could hinder the achievement of its goals. These include a lack of funding to scale up green technologies, the difficulty of changing traditional economic policies that rely on the depletion of natural resources, and the need for international cooperation and strong political will to overcome economic and social obstacles [7].

The transition to a green economy requires these factors. Some Arab countries, including Iraq, still adopt development strategies dominated by investments in export-oriented extractive commodities such as oil derivatives. This has led to weak economic structures in Arab countries, as they rely on a single source of income [8]. Furthermore, the prevailing economic planning in some Arab countries, including Iraq, still focuses on short-term GDP growth. Hence, the necessity of transforming the Iraqi economy into a sustainable green economy becomes clear. This would reduce dependence on traditional energy sources and address the problems hindering sustainable development. Iraq suffers from pollution, poor water management, desertification, neglect of innovation and scientific research, a lack of public awareness, and deteriorating infrastructure, which is fundamental to sustainable development, of which the green economy is a crucial component. Therefore, it is imperative for Iraq to accelerate its transition to a sustainable green economy to catch up with the progress witnessed in the developed world today. This transition addresses the economic and environmental challenges that impede the desired development process. A sustainable, low-carbon economy protects the rights of both current and future generations. The transition to a green economy requires a fundamental review and restructuring of public policies within society, as well as the participation of all stakeholders. Popularity at all levels is directed by a policy from the top of the pyramid in the state to the base [9].

The Problem of the Study

ISSN 2072-3857

The problem addressed by this study lies in the obstacles hindering the application of green economy principles as a framework for achieving sustainable development within current economic trends that often prioritize economic growth without sufficient consideration for environmental and social dimensions. Despite global recognition of the importance of the green economy as a fundamental pillar for maintaining ecological balance and achieving sustainability, the transition to this economic model faces numerous obstacles, including a lack of awareness, the absence of appropriate policies, and financial challenges, all of which impede the achievement of desired goals. Furthermore, the relationship between the green economy and sustainable development still requires deeper clarification, particularly regarding how to balance economic development with environmental protection and social justice.

Based on the above, this study focuses on the main question: How does the green economy contribute to achieving sustainable development in Iraq, and what challenges hinder its effective implementation within current economic systems?

The problem of the study can be formulated through the following sub-questions:

1. What is the relationship between adopting green economy strategies and achieving long-term sustainable economic development?

2. How can the green economy contribute to mitigating the negative impacts of climate change and promoting environmental sustainability? 3. What are the main challenges facing countries in implementing green economy strategies, and how can they be overcome?

4. What role does green technology play in achieving sustainable development goals?

Study Objectives

This study aims to achieve the following objectives:

1. Analyze the relationship between adopting green economy strategies and achieving long-term sustainable economic development.

2. Evaluate the role of the green economy in mitigating the negative impacts of climate change and promoting environmental sustainability.

3. Identify the main obstacles facing countries in implementing green economy strategies and propose solutions to overcome them.

The study's hypothesis

The study's hypothesis is based on the following points:

• There is a statistically significant positive relationship between adopting green economy policies and the growth of sustainable economic development in the long term, with a correlation coefficient (r) greater than 0.5 and a significance level of $p < 0.05$.

• There is a statistically significant positive relationship between implementing green economy principles and reducing the negative impacts of climate change and enhancing environmental sustainability.

ISSN 2072-3857

• There is a statistically significant positive relationship between the challenges countries face in implementing green economy strategies and the effectiveness of implementing these strategies.

Data Sources and Analysis Methodology

The study relies on secondary data, specifically time series data for the period 2004-2025. This data will be obtained from governmental and international sources such as the Ministry of Agriculture, the Ministry of Planning/Central Statistical Organization (for Iraq), the Food and Agriculture Organization of the United Nations (FAO), the World Trade Organization (WTO), and various online sources. The analysis methodology will utilize a specific model.

Material and Methods

Autoregressive Distributed Lag (ARDL)

In 2001, Pesaran, Shin, and Smith published their renowned research on the Autoregressive Distributed Lag (ARDL) Bounds Test, abbreviated as the PSS 2001 approach. This approach distinguishes itself by overcoming the limitations of traditional cointegration modeling, which assumes a stability condition or cointegration of the same degree for the studied series. This is what earned it academic acclaim, as this approach does not assume stability of the same degree unless there are stable series of degree I(2) or higher (Pesaran et al., 2001, p. 26). As for the variables, the model description and the selection of variables are determined by a set of factors, some of which are related to the concepts of economic theory and some of which are factors used in studies in the relevant field, in addition to the specificity of the economy under study. Hence, it was decided to select these variables because they include economic shocks, as previously explained, which may affect the dependent variable in one way or another, whether immediately or incrementally. Accordingly, the mathematical model of the ARDL method for the time series extending from 2004 - 2025 was described using semi-annual data as follows:

$$AGDP = \beta_0 + \beta_1 GDP + \beta_2 GGDP + \beta_3 ISA + \beta_4 EA + \beta_5 WR + u$$

Where:

AGDP: Agricultural GDP (dependent variable - millions of dinars).

GDP: Gross Domestic Product (first independent variable - millions of dinars).

GGDP : Green GDP (second independent variable - millions of dinars).

ISA: Investment allocations to the agricultural sector (third independent variable - millions of dinars).

EA : Environmental allocations (fourth independent variable - millions of dinars).

WR : Water inflow to the Tigris and Euphrates rivers (fifth independent variable - billion cubic meters).

β_0 Intercept.

β_1 - β_5: Model parameters (estimated regression coefficients for independent variables).

u: Random error term.

Results and Discussion

Economic variables are typically characterized by instability due to their inherent economic nature, a fact confirmed by most studies and research. Several methods exist for determining the stationarity of time series, with the

ISSN 2072-3857

Extended Dickey-Fuller Test (ADF) being one of the most important. The stationarity of the variables included in the model was tested using the Extended Dickey-Fuller Test (ADF) to confirm the stationarity of the study's time series at the original level and at the first difference, with a fixed term, a fixed term with a general trend, and without a fixed term and general trend. Table (1) shows the results of the analysis:

Table (1) : Results of the stationarity of the variables using the Extended Dickey-Fuller Test (ADF)

UNIT ROOT TEST RESULTS TABLE (ADF)
Null Hypothesis: the variable has a unit root

At Level

		AGDP	GDP	GGDP	ISA	EA	WR
With Constant	t-Statistic	-3.6895	-1.6037	-2.4019	-1.6554	-1.8777	-2.1660
	Prob.	***0.0079***	***0.4717***	***0.1476***	***0.4458***	***0.3391***	***0.2214***
		***	n0	n0	n0	n0	n0
With Constant & Trend	t-Statistic	-4.1714	-3.5252	-2.9376	-2.0502	-3.1660	-2.8391
	Prob.	***0.0107***	***0.0498***	***0.1624***	***0.5572***	***0.1061***	***0.1928***
		**	**	n0	n0	n0	n0
Without Constant & Trend	t-Statistic	-0.6848	0.4722	-0.5320	-0.9666	-1.2915	-1.1194
	Prob.	***0.4142***	***0.8125***	***0.4801***	***0.2929***	***0.1781***	***0.2345***
		n0	n0	n0	n0	n0	n0

At First Difference

		d(AGDP)	d(GDP)	d(GGDP)	d(ISA)	d(EA)	d(WR)
With Constant	t-Statistic	-3.2841	-3.5825	-5.6863	-3.6205	-5.6417	-7.3634
	Prob.	***0.0222***	***0.0105***	***0.0000***	***0.0095***	***0.0000***	***0.0000***
		**	**	***	***	***	***
With Constant & Trend	t-Statistic	-3.2645	-3.5599	-5.7743	-3.7693	-5.6221	-7.4153
	Prob.	***0.0866***	***0.0461***	***0.0001***	***0.0286***	***0.0002***	***0.0000***
		*	**	***	**	***	***
Without Constant & Trend	t-Statistic	-3.3413	-3.3747	-5.5506	-3.6665	-5.7168	-7.3811
	Prob.	***0.0014***	***0.0012***	***0.0000***	***0.0005***	***0.0000***	***0.0000***
		***	***	***	***	***	***

Notes:
a: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1% and (no) Not Significant
b: Lag Length based on SIC
c: Probability based on MacKinnon (1996) one-sided p-values.

This Result is The Out-Put of Program Has Developed By:
Dr. Imadeddin AlMosabbeh
College of Business and Economics
Qassim University-KSA

Source: Compiled by the researcher using the statistical 1software Eviews 10.

The results in Table (1) indicate that some variables have stabilized at the same level, while others have reached the initial difference. The ARDL model will be described here.

Estimation using the Autoregressive Distributed Lag (ARDL) model:

The ARDL model uses the cointegration test developed by Pesaran in 2001, specifically the Bound Test. It is used when the sample size is small, unlike the cointegration tests of Engel, Granger, and Johansen, which require large sample sizes for more accurate and efficient results. The general formula for the ARDL model is:

$$\Delta AGDP = a_o + a_1 GDP_{t-1} + a_2 X2GGDP_{t-1} + a_3 ISA_{t-1} + a_4 X4EA_{t-1} + a_5 WR_{t-1} + \sum_{i=1}^{m} B_1 \Delta AGDP_{t-1} + \sum_{i=1}^{m} B_2 \Delta GDP_{t-1} + \sum_{i=1}^{m} B_3 \Delta GGDP_{t-1} + \sum_{i=1}^{m} B_4 \Delta ISA_{t-1} + \sum_{i=1}^{m} B_5 \Delta EA_{t-1} + \sum_{i=1}^{m} B_6 \Delta WR_{t-1} + Et$$

ISSN 2072-3857

Testing the ARDL model involves verifying the existence of a long-term equilibrium relationship between the model variables. If this relationship is confirmed, the next step is to estimate the long-term parameters based on two hypotheses:

H0: $\beta = 0$: The null hypothesis, which states that there is no cointegration (i.e., no long-term equilibrium relationship between the model variables).

H1: $\beta \neq 0$: The alternative hypothesis, which states that there is cointegration (i.e., a long-term equilibrium relationship between the study variables). The F-statistic is compared with tabulated values, which have upper and lower limits. If the calculated F-value is greater than the upper limit of the critical values, we reject the null hypothesis (which states that there is no long-term equilibrium relationship between the model variables) and accept the alternative hypothesis (which states that there is cointegration between the model variables). If the F-value is less than the lower limit of the critical values, we accept the null hypothesis (which states that there is no long-term equilibrium relationship between the model variables) and reject the alternative hypothesis (which states that there is cointegration between the model variables). If the F-value falls between the upper and lower limits, then the relationship is considered non-deterministic (Ashri, 2022: 309-311).

Several attempts were made to obtain the best estimated results in terms of conformity to the criteria and freedom from problems, etc. The results mentioned in Table (2) were the best results obtained, which included applying the (ARDL) model using the (Eviews 10) program. The table shows the estimation results for the effect of the independent variables with their slowing periods on the dependent variable, as well as the effect of the slowing periods of the dependent variable itself. The results showed the selection of the formula (2,4,4,5,5,5) which is the best result obtained out of (15552) models that were self-analyzed by the software, as shown in Figure (1). It appeared that R2 reached (0.99), which means that (99%) of the fluctuations are due to the variables included in the model, and the remainder is due to variables that were not included in the model, and their effect was absorbed by the random variable.

ISSN 2072-3857

Table(2). Initial estimate of the estimated ARDL model

Dependent Variable: AGDP
Method: ARDL
Date: 08/03/26 Time: 01:29
Sample (adjusted): 2006S2 2025S2
Included observations: 39 after adjustments
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (5 lags, automatic): GDP GGDP ISA EA WR
Fixed regressors: C
Number of models evalulated: 15552
Selected Model: ARDL(2, 4, 4, 5, 5, 5)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
AGDP(-1)	0.873501	0.064938	13.45140	0.0000
AGDP(-2)	-0.110540	0.077958	-1.417951	0.1940
GDP	0.059830	0.007203	8.306412	0.0000
GDP(-1)	-0.053580	0.009679	-5.535640	0.0006
GDP(-2)	0.024279	0.009242	2.626971	0.0303
GDP(-3)	-0.057315	0.011872	-4.827671	0.0013
GDP(-4)	-0.017961	0.007264	-2.472603	0.0386
GGDP	-0.016481	0.004358	-3.781999	0.0054
GGDP(-1)	0.036263	0.007835	4.628260	0.0017
GGDP(-2)	0.024132	0.008174	2.952123	0.0184
GGDP(-3)	0.028596	0.008249	3.466427	0.0085
GGDP(-4)	0.040612	0.007525	5.396938	0.0006
ISA	-3.929919	0.413526	-9.503431	0.0000
ISA(-1)	3.979077	0.578884	6.873706	0.0001
ISA(-2)	-3.298291	0.571526	-5.771027	0.0004
ISA(-3)	1.456477	0.455243	3.199338	0.0126
ISA(-4)	-7.340879	0.767666	-9.562596	0.0000
ISA(-5)	6.372952	0.643407	9.905001	0.0000
EA	30.67361	6.534407	4.694169	0.0016
EA(-1)	-12.07068	8.110621	-1.488256	0.1750
EA(-2)	-39.51648	8.155563	-4.845340	0.0013
EA(-3)	47.79474	9.613842	4.971450	0.0011
EA(-4)	21.55500	11.75635	1.833476	0.1041
EA(-5)	-28.04396	9.203866	-3.046976	0.0159
WR	84593.72	9776.719	8.652567	0.0000
WR(-1)	-71892.44	13523.38	-5.316159	0.0007
WR(-2)	140319.7	19898.66	7.051715	0.0001
WR(-3)	-31952.84	13134.58	-2.432727	0.0410
WR(-4)	216648.7	24318.45	8.908819	0.0000
WR(-5)	-146094.8	19732.12	-7.403904	0.0001
C	-2084033.	1242068.	-1.677873	0.1319

R-squared	0.998300	Mean dependent var	6365360.
Adjusted R-squared	0.991924	S.D. dependent var	1516384.
S.E. of regression	136268.3	Akaike info criterion	26.48826
Sum squared resid	1.49E+11	Schwarz criterion	27.81058
Log likelihood	-485.5211	Hannan-Quinn criter.	26.96270
F-statistic	156.5855	Durbin-Watson stat	3.407991
Prob(F-statistic)	0.000000		

ISSN 2072-3857

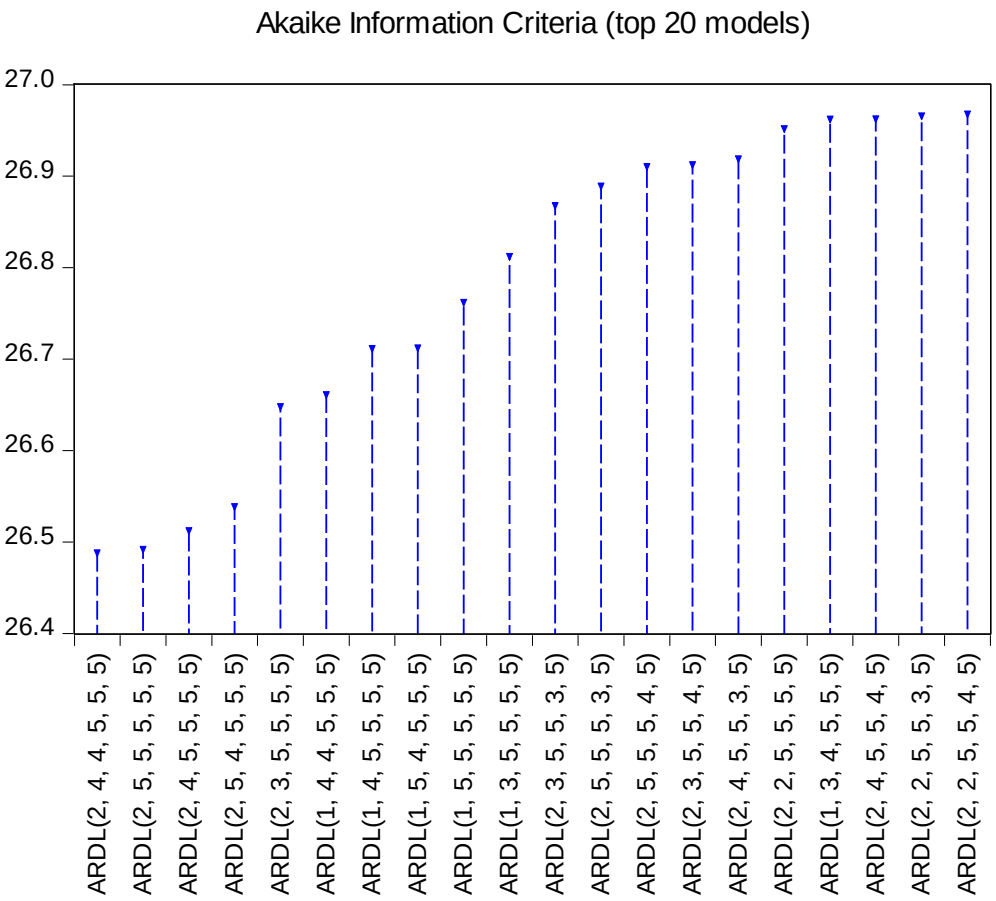


Figure (1). Best estimated model according to the Akaike criterion.

Source: Eviews 10 software output.

Analysis and Testing of the ARDL Model

Normalized Distribution Test

This statistical test examines the normality of a series. The test statistic measures the difference in skewness and kurtosis of the series compared to a normal distribution. It is calculated as follows:

Jarque-Bera = N/6(S^2 + (K - 3)^2/4)

where: S is skewness and K is kurtosis.

Under the null hypothesis of a normal distribution, the Jarque-Bera statistic follows a chi-squared distribution (χ^2) with 2 degrees of freedom. The resulting probability is the probability that the Jarque-Bera statistic (in absolute terms) exceeds the observed value. A small probability value leads to the rejection of the null hypothesis of a normal distribution and acceptance of the alternative, thus the variable is not normally distributed. Figure (2) and the attached table show the non-significance of the Jarque-Bera test, as it reached (0.97), which means accepting the null hypothesis that states the normal distribution of the estimated ARDL model residual series.

ISSN 2072-3857

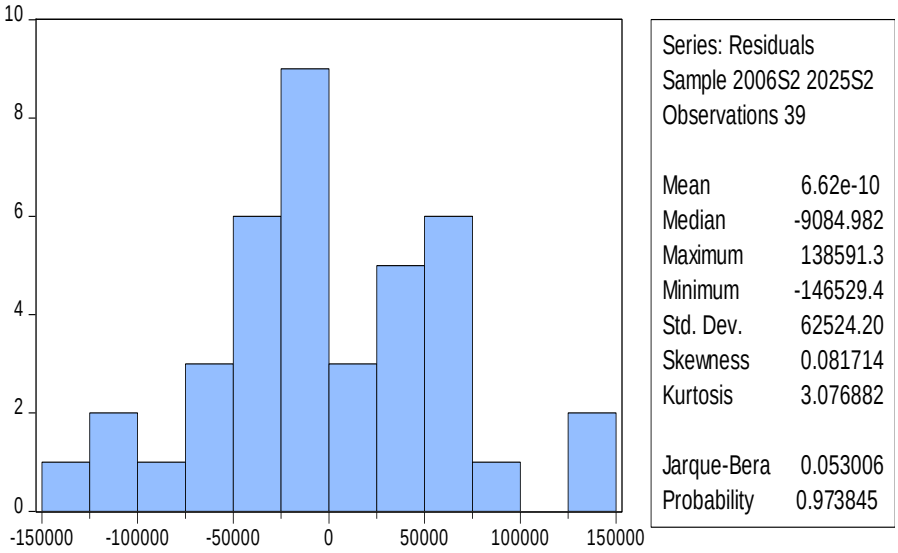


Figure 2. Testing the normality of residues according to the Jarque-Bera criterion.

Source: Eviews 10 software output.

B) Breusch-Godfrey Serial Correlation Test

One of the important tests in this field is the serial autocorrelation test for the error term in the model using the Lagrange Multiplier Serial Correlation LM Test, which was developed by Breusch and Godfrey in 1978. The results, as shown in Table (3), showed that there is no autocorrelation in light of the results of the LM test by comparing the probability of the Chi-Square statistic of (0.70) which is greater than (0.05), and therefore we accept the null hypothesis, meaning that the model is good and there is no serial autocorrelation in For errors.

Table 3. LM Lagrange multiplier test

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.116284	Prob. F(1,33)	0.7353
Obs*R-squared	0.147478	Prob. Chi-Square(1)	0.7010

Source: Eviews 10 software output.

c) Heteroskedasticity Test

Based on the Breusch-Pagan-Godfrey (BPG) test, the calculated F-value was obtained at 2.36, with a significance level of 0.10. The results of the variance test performed on the model also confirmed that the Chi-Square value was 0.24, which is greater than 0.05. Therefore, there is no variance in the error threshold, and the null hypothesis is accepted, meaning there is no problem, as shown in Table (4).

Table 4: Heteroskedasticity Test

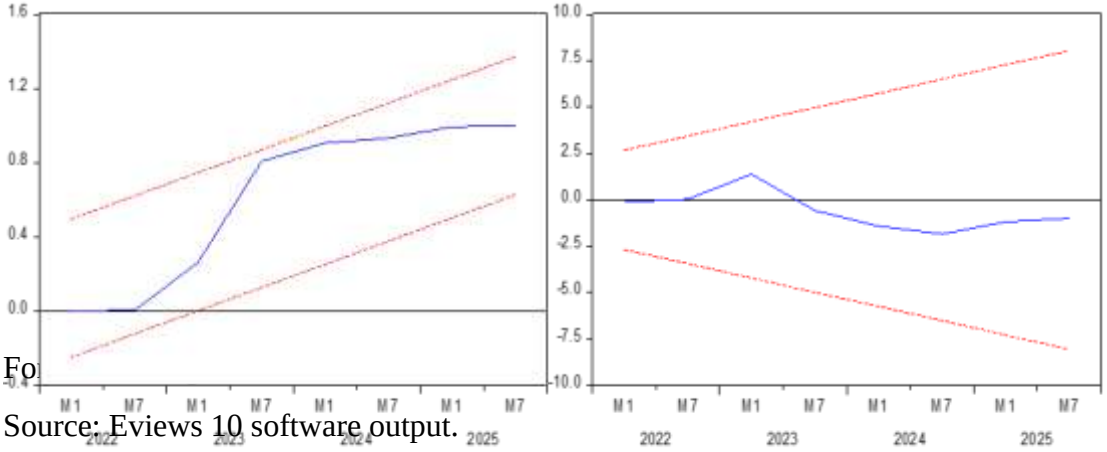
Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	2.369181	Prob. F(30,8)	0.1015
Obs*R-squared	35.05440	Prob. Chi-Square(30)	0.2407
Scaled explained SS	1.531705	Prob. Chi-Square(30)	1.0000

d) CUSUM and CUSUMSQ Reliability Tests

The cumulative sum and cumulative sum square tests are structural stability tests for the model in the short and long run. Structural stability is achieved for the estimated ARDL model coefficients (2, 4, 4, 5, 5, 5) if the graph of both the CUSUM and CUSUMSQ statistics falls within the critical limits at a significance level of 5%. These coefficients are considered unstable if the graph of the aforementioned tests falls outside the critical limits at this level.

The results showed structural stability among the study variables and model consistency in both the short and long run, as shown in Figure (3):



Fo

Source: Eviews 10 software output.

1. ECM E

The following short-term (error correction) model was applied in the estimation:

$$d(AGDP_t) = \beta_0 + \sum_{i=1}^{k} \beta_1\, dAGDP_{t-i} + \sum_{i=1}^{k} \beta_2\, dGDP_{t-i} + \sum_{i=0}^{k} \beta_3\, dGGDP_{t-i} + \sum_{i=0}^{k} \beta_4\, dISA_{t-i} + \sum_{i=0}^{k} \beta_5\, dEA_{t-i} + \sum_{i=0}^{k} \beta_6\, dWR_{t-i}$$

Where: k is the number of lags, i'sβ is the short-term parameter of the error correction model, and εi is the random error.

What is important in this context is that the error correction coefficient (CointEq(-1)) appears significant as a necessary condition and negative as a sufficient condition. The negative sign indicates a cointegration relationship and the possibility of correcting short-term errors to return to long-term equilibrium. The absolute value of this ability is the proportion of errors that can be corrected per unit of time; that is, if a shock occurs, this proportion can be corrected per unit of time (year).

Table(4): Short-term model or error correction model

ARDL Error Correction Regression
Dependent Variable: D(AGDP)
Selected Model: ARDL(2, 4, 4, 5, 5, 5)
Case 2: Restricted Constant and No Trend
Date: 08/03/26 Time: 01:41
Sample: 2004S1 2025S2
Included observations: 39

ECM Regression
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(AGDP(-1))	0.110540	0.033187	3.330790	0.0104
D(GDP)	0.059830	0.003496	17.11508	0.0000
D(GDP(-1))	0.050996	0.002967	17.18742	0.0000
D(GDP(-2))	0.075275	0.004422	17.02256	0.0000
D(GDP(-3))	0.017961	0.002748	6.534895	0.0002
D(GGDP)	-0.016481	0.002255	-7.309861	0.0001
D(GGDP(-1))	-0.093339	0.003924	-23.78459	0.0000
D(GGDP(-2))	-0.069208	0.003684	-18.78666	0.0000
D(GGDP(-3))	-0.040612	0.002633	-15.42473	0.0000
D(ISA)	-3.929919	0.162737	-24.14886	0.0000
D(ISA(-1))	2.809742	0.209750	13.39567	0.0000
D(ISA(-2))	-0.488549	0.183688	-2.659665	0.0288
D(ISA(-3))	0.967927	0.186075	5.201813	0.0008
D(ISA(-4))	-6.372952	0.255400	-24.95282	0.0000
D(EA)	30.67361	2.627175	11.67551	0.0000
D(EA(-1))	-1.789301	2.786943	-0.642030	0.5388
D(EA(-2))	-41.30578	3.559061	-11.60581	0.0000
D(EA(-3))	6.488960	3.821484	1.698021	0.1279
D(EA(-4))	28.04396	2.954419	9.492207	0.0000
D(WR)	84593.72	4228.806	20.00416	0.0000
D(WR(-1))	-178920.7	7410.114	-24.14547	0.0000
D(WR(-2))	-38601.05	5911.927	-6.529351	0.0002
D(WR(-3))	-70553.89	5675.457	-12.43140	0.0000
D(WR(-4))	146094.8	7625.224	19.15941	0.0000
CointEq(-1)*	-0.237039	0.008953	-26.47527	0.0000

R-squared	0.994053	Mean dependent var	-11799.95
Adjusted R-squared	0.983858	S.D. dependent var	810757.8
S.E. of regression	103009.2	Akaike info criterion	26.18057
Sum squared resid	1.49E+11	Schwarz criterion	27.24696
Log likelihood	-485.5211	Hannan-Quinn criter.	26.56318
Durbin-Watson stat	3.407991		

* p-value incompatible with t-Bounds distribution.

The results in Table (4) show that the error correction coefficient is (-0.23), which is significant at (1%). This is interpreted as meaning that addressing the shock (or short-term deviation) occurring in this model requires more than a year, since (23%) of the shock's effects are addressed within a single year. The time required to correct the shock's effect and return to the correct state is equal to the reciprocal of this percentage, i.e., (1/0.23 = 4.34) years, or approximately (2) years and

ISSN 2072-3857

three months, as the data is semi-annual. The error correction model represents a short-term model, in which errors or shocks affecting the model are corrected, restoring it to its original equilibrium state.

Long-Run Function and Boundary Test: This test presents the long-run parameters, which, by definition, refer to the long-term relationship, as well as the boundary test. The first part of Table (5) shows the long-run information. The information for the variables without the differences (D) pertains to the long-run function, from which the long-run function can be derived using the equation ($\beta_n = -\lambda_n/\lambda_1$), where β is the estimated value and λ is the known value. This is found in the table under the heading "Levels Equation." The variables with the differences (D) pertain to the short-run function or the error correction model.

Table (5) Long-Run Equation

ARDL Long Run Form and Bounds Test
Dependent Variable: D(AGDP)
Selected Model: ARDL(2, 4, 4, 5, 5, 5)
Case 2: Restricted Constant and No Trend
Date: 08/03/26 Time: 01:39
Sample: 2004S1 2025S2
Included observations: 39

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-2084033.	1242068.	0.000000	0.0000
AGDP(-1)*	-0.237039	0.046854	-5.059124	0.0010
GDP(-1)	-0.044746	0.005676	-7.883763	0.0000
GGDP(-1)	0.113121	0.012257	9.228903	0.0000
ISA(-1)	-2.760584	0.225328	-12.25142	0.0000
EA(-1)	20.39223	8.585785	2.375116	0.0449
WR(-1)	191622.0	28341.49	6.761184	0.0001
D(AGDP(-1))	0.110540	0.077958	1.417951	0.1940
D(GDP)	0.059830	0.007203	8.306412	0.0000
D(GDP(-1))	0.050996	0.007339	6.948320	0.0001
D(GDP(-2))	0.075275	0.009425	7.987142	0.0000
D(GDP(-3))	0.017961	0.007264	2.472603	0.0386
D(GGDP)	-0.016481	0.004358	-3.781999	0.0054
D(GGDP(-1))	-0.093339	0.011310	-8.252784	0.0000
D(GGDP(-2))	-0.069208	0.007858	-8.806832	0.0000
D(GGDP(-3))	-0.040612	0.007525	-5.396938	0.0006
D(ISA)	-3.929919	0.413526	-9.503431	0.0000
D(ISA(-1))	2.809742	0.496956	5.653901	0.0005
D(ISA(-2))	-0.488549	0.278188	-1.756182	0.1171
D(ISA(-3))	0.967927	0.278551	3.474859	0.0084
D(ISA(-4))	-6.372952	0.643407	-9.905001	0.0000
D(EA)	30.67361	6.534407	4.694169	0.0016
D(EA(-1))	-1.789301	7.657162	-0.233677	0.8211
D(EA(-2))	-41.30578	7.225382	-5.716761	0.0004
D(EA(-3))	6.488960	8.436157	0.769184	0.4639
D(EA(-4))	28.04396	9.203866	3.046976	0.0159
D(WR)	84593.72	9776.719	8.652567	0.0000
D(WR(-1))	-178920.7	31064.48	-5.759656	0.0004
D(WR(-2))	-38601.05	18671.16	-2.067416	0.0725
D(WR(-3))	-70553.89	15852.60	-4.450619	0.0021
D(WR(-4))	146094.8	19732.12	7.403904	0.0001

* p-value incompatible with t-Bounds distribution.

Table (5) indicates the long-run parameters in the upper part of the table, i.e., before taking the first difference. The differences represent the short-run parameters.

The results from Table (5) show that the Gross Domestic Product (GDP) had a statistically significant negative impact on the value of agricultural GDP in Iraq (-0.044746) with a statistical significance of (0.0000). This is due to the Dutch Disease, whereby Iraq's GDP depends on the oil sector for more than 85% of its output. When oil prices rise, GDP increases, but this rise is accompanied by increased government consumption spending, a rise in the real exchange rate, and an increase in cheap commodity and food imports from neighboring countries. This weakens the competitiveness of local agricultural products and leads to their decline (the oil sector crowding out the agricultural

sector). The results also indicate that the Green GDP (GGDP) came in with a positive parameter (+0.113121) with a statistical significance of (0.0000). Since increasing green output leads to increased agricultural output in the long run, this supports the hypothesis that the transition to a green economy (conserving natural resources, reducing pollution, and managing natural capital) promotes sustainable agricultural productivity. Agriculture is the first sector affected by environmental degradation; therefore, environmentally sound economic growth ensures the preservation of soil and water, which positively impacts production volumes. The results also indicated that investment allocations for the agricultural sector (ISA) had a negative value (-2.760584) and a statistical significance level of 0.0000. This result may seem economically illogical (since investment is supposed to increase production). Furthermore, weak investment efficiency and administrative corruption, along with the diversion of a large portion of public sector investment allocations to unproductive operational expenses or stalled projects that have not yet entered actual service, contribute to this. In addition to the time gap in implementation, major government investment projects take many years to complete without a quick positive return, representing a financial burden without corresponding production. Moreover, the prioritization of consumer spending and the government's inefficient subsidization of inputs do not incentivize genuine private investment in modern technology.

The results also indicated that environmental allocations (EA) had a very large positive coefficient (+20.39223) and a statistical significance level of 0.0449, as allocating financial resources to the environment has a strong impact on supporting agricultural output. Environmental spending in Iraq is directed towards addressing soil salinity and combating desertification. Protecting river channels. These measures restore damaged land to productive use and increase yield per acre.

The results also indicated that the water inflow of the Tigris and Euphrates rivers (WR) had a very high positive coefficient (+191622.0) and high statistical significance (0.0001). Water is the dominant variable and the backbone of the agricultural sector in Iraq, and the majority of Iraqi agriculture depends on surface irrigation from the Tigris and Euphrates rivers. Any increase in water resources translates directly into an increase in cultivated areas and crop diversification, while water scarcity leads to vast areas being taken out of service (a decline in the agricultural plan).

As for interpreting the parameters in the short term, the results indicated that the short-term gross domestic product (GDP) had a positive (+0.059830) and significant effect, because an increase in GDP in the short term supports the purchasing power of the population, which increases local demand for fresh agricultural products. However, the short-term green GDP (GGDP) had a negative effect due to the costs of adaptation and transition, as the transition to green policies in the short term requires Restructuring and eliminating some costly traditional methods will temporarily reduce production before its long-term positive effects become apparent. Furthermore, environmental specializations (D(EA)) and water input (D(WR)) have had a rapid and decisive positive impact on current agricultural production in the short term.

ISSN 2072-3857

Table (6) Bound-test results

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP	-0.188772	0.055062	-3.428324	0.0090
GGDP	0.477224	0.122509	3.895421	0.0046
ISA	-11.64611	2.545054	-4.575979	0.0018
EA	86.02898	42.40998	2.028508	0.0770
WR	808398.3	187164.6	4.319184	0.0025
C	-8791937.	5029284.	-1.748149	0.1186

EC = AGDP - (-0.1888*GDP + 0.4772*GGDP -11.6461*ISA + 86.0290*EA + 808398.3029*WR -8791937.0453)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	57.21960	10%	2.08	3
k	5	5%	2.39	3.38
		2.5%	2.7	3.73
		1%	3.06	4.15
Actual Sample Size	39		Finite Sample: n=40	
		10%	2.306	3.353
		5%	2.734	3.92
		1%	3.657	5.256
			Finite Sample: n=35	
		10%	2.331	3.417
		5%	2.804	4.013
		1%	3.9	5.419

Table (6) refers to the bounds test for the model as a whole, which can be deduced by comparing the F-statistic with the lower and upper limits. If the F-statistic is greater than the upper limit at a certain significance level, the model is considered good and there is cointegration between the variables (levels equation). If the F-statistic is less than the lower limit at the relevant level, this indicates acceptance of the null hypothesis and the absence of cointegration. If the F-statistic falls between the two limits, the conclusion is not definitive. Returning to the test result, we find that the F-statistic reached (57.2), which is greater than the upper limit at a significance level of (1%), indicating cointegration between the variables.

Conclusions

1- The study concludes that the symptoms of "Dutch Disease" and the duality of economic activity (GDP) reflect the negative impact of GDP on agricultural output. This reflects the Iraqi economy's suffering from symptoms of "Dutch Disease," stemming from the dominance of the rentier oil sector. When GDP rises due to oil price increases, financial flows increase, and the state and market system tend to expand imports of cheap food and agricultural products. This, coupled with rising real exchange rates and escalating wages in non-reciprocal sectors (such as government services), leads to the diversion of capital and labor from the agricultural sector and a decline in its competitiveness.

2- The Importance of Water and the Environment: The model demonstrates that environmental and water variables (WR, EA, GGDP) are the primary and essential drivers of sustainable agricultural investment growth in Iraq.

ISSN 2072-3857

3- There is a clear weakness in environmental allocations at the national level in Iraq since 2003. This may be attributed to the state's prioritization of allocations to other sectors, particularly the oil sector, and the military sector due to the security situation during the study period. The negative indicator is attributed to several structural imbalances, most notably:

4- Weak management of government investment projects and the dissipation of allocated funds on associated operational expenses.

5- The phenomenon of stalled projects that drain financial resources without entering the actual production phase.

6- The absence of modern marketing mechanisms and technical support, resulting in financial waste that is not reflected in an increase in agricultural added value.

7- The result indicates that water imports constitute the decisive structural determinant and the most influential element in the sustainability and productivity of the Iraqi agricultural sector. This high elasticity reflects the historical and structural dependence of Iraqi agriculture on traditional surface irrigation Based on the preceding conclusions, we recommend the following:

1- Formulating a strategy for water security and water diplomacy: It is essential to activate international and bilateral agreements with neighboring countries (Turkey and Iran) to establish fair and sustainable water quotas for Iraq in the Tigris and Euphrates rivers, and to prioritize water issues in foreign policy and national security.

2- Modernizing irrigation and distribution systems: Accelerating the elimination of traditional surface irrigation systems and replacing them entirely with modern water. Cultivated areas and yields are directly and sharply affected by any change in water allocations from neighboring countries (upstream countries), which directly impacts food security levels and agricultural output.

8- The validity of the green economy hypothesis in the long term, as spending directed towards environmental protection and addressing environmental degradation achieves positive externalities that benefit the agricultural sector. Addressing salinity, combating desertification, stabilizing soils, and managing natural resources directly contribute to protecting agricultural assets and restoring degraded lands.

9- While the short-term results showed a negative D(GGDP) coefficient, this suggests that there are short-term structural transformation costs borne by sectors when transitioning to emissions standards and environmental requirements before these costs yield long-term developmental benefits.

Recommendations

closed-loop irrigation, drip irrigation, and center-pivot irrigation systems to increase water use efficiency and reduce water losses due to evaporation.

3- Establishing water harvesting and treatment infrastructure: Expanding the construction of small dams (water harvesting dams) in desert areas and developing wastewater recycling plants for use in irrigating green belts.

4- Increasing and diversifying environmental (EA) funding: Increasing the percentage of government spending directed towards environmental projects, specifically national initiatives to combat

ISSN 2072-3857

desertification, and establishing green belts around Iraqi cities to protect agricultural lands from desertification. 5. Adopt green accounting and GGDP applications: Integrate green GDP indicators into national development planning systems and the state budget by allocating budgets to assess consumption and depreciation of natural capital and the cost of pollution and environmental erosion.

5. Support and facilitate short-term transition costs: Provide incentives, tax exemptions, and financial support to farmers and agricultural companies that adopt green technologies and bio-fertilizers to mitigate "adaptation costs" in the initial stages of the transition.

6. Restructure the government investment spending management mechanism (ISA): Shift from traditional spending methods to "program and performance budgeting," where financial allocations are linked to indicators measuring productivity and the actual value added.

7. Activate public-private partnerships (PPPs): Reduce reliance on direct government investment budgets and encourage private, local, and foreign investment in agricultural manufacturing projects, cold chains, and storage, while protecting local products. 9- Resolving the issue of stalled investment projects: Subjecting all current government agricultural investment projects to financial and technical evaluation and auditing, liquidating unviable projects, and redirecting resources towards technologically advanced projects.

8- Implementing customs protection policies and the agricultural calendar: Strictly enforcing laws protecting local producers and consumers, and controlling border crossings to prevent the market from being flooded with cheap imported agricultural products during peak local production seasons.

9- Establishing a Sustainable Agriculture Stabilization and Development Fund: Allocating a percentage of oil revenues when global oil prices rise to a sovereign investment fund to support agricultural technology and mitigate the impact of oil price shocks and climate fluctuations.

10- Subsidizing agricultural inputs to reduce costs: Providing direct support for energy prices, hybrid seeds, and technological equipment for the agricultural sector to mitigate its declining competitiveness compared to other sectors whose wages are inflated by oil revenues.

References

[1] Al-Husseini, Osama Muhammad, 2015. The Green Economy – Part One: Environment and Biodiversity. Screen Line Company – Cairo**.**

[2] Nagaty, Hossam El-Din, 2014. "The Green Economy and its Role in Achieving Sustainable Development" Planning and Development Issues Series No. 2015, National Planning Institute, Egypt.

[3] Kazim, Iman Abdul Rahim, 2013. The Green Economy: A Path to Evaluating Economic Growth – Experiences of Selected Countries with Reference to Iraq (Unpublished Master's Thesis). College of Administration and Economics - University of Karbala**.**

[**4**] **Bakhta, Bataher, 2019.** Green buildings as a pillar for promoting the requirements of the transition to a green economy - Sustainable green architecture as a model. Al-Aseel Journal of Economic and Administrative Research, 3(2), 197-212.

ISSN 2072-3857

[5] Adamowicz, M., 2022. Green deal, green growth and green economy as a means of support for attaining the sustainable development goals. Sustainability, 14(10), p.5901.

[6] Akhmetshina, L., Pokrovskaya, T. and Semernin, D., 2018. Organic agriculture and sustainable development of the agrarian sector of regions in the context of "green" economy. In MATEC Web of Conferences (Vol. 193, p. 05047). EDP Sciences.

[7] Akpaeti, A.J., Udo, U.J. and Bassey, N.E., 2015. Boosting agricultural productivity through financing and marketing of green economy in Nigeria. Nigerian Journal of Agricultural Economics, 5(1), pp.46-53.

[8] Al-Gurairy, A.S.Y. and Al-Zubaidi, A.H.A., 2023. Climate Change and Its Impact on the Expansion of the Phenomenon of Sand Dunes and Desertification of Agricultural Lands in Iraq for the Period 1984-2022 (Governorates of Al-Qadisiyah, Al-Muthanna, and Dhi Qar). Israa University Journal of Applied Science ,7(1),pp.75-96.

[9] Abdullah, Saif Shihab Ahmed, 2022. The Impact of Applying the Green Economy in the Agricultural Sector on the Problems of Unemployment and Poverty in Iraq. Journal of Geographical Research, 25(1), 127-150.

ISSN 2072-3857