Green economy as a strategy and essential framework for the transition of development in Iraq: A case study of the agricultural sector

Anwar Mohsen Sagab[1]*, Rahim Hadi Nasser Al-Aqabi[2]

[1] Department of Economics, College of Administration and Economics, Wasit University, Iraq
[2] Wasit Agriculture Directorate, Iraq
*Corresponding author, email: anwar@uowasit.edu.iq

doi: 10.17977/um063.v6.i3.2026.7

Keywords
Green economy
GDP
Agricultural sector
Sustainable development
Forecasting

Abstract
The aim of this research is to demonstrate the role of the green economy in achieving sustainable agricultural development in Iraq through the agricultural sector's contribution to GDP. The transition to a green economy in Iraq is measured by several indicators, including the GDP index and the extent of the agricultural sector's contribution to the growth of this index. Iraq's GDP increased from 15,093,144 million dinars to 252,654,600 million dinars during the period from 1997 to 2023. Despite this economic growth, and although the absolute contribution of the agricultural sector to GDP continued to increase from 1997 to 2023, its percentage share decreased from 8.5% to 3.3% relative to the increase in GDP. A statistical analysis was conducted for the studied variables, and the results showed a direct relationship between GDP and the agricultural sector variable, with a probability value of 0.0000, which is less than 0.05 and statistically significant at the 1% level. This means that GDP is positively affected by the agricultural sector at the 99% confidence level: the higher the value of the agricultural sector's contribution, the higher the value of GDP.

1. Introduction

The "green economy" is an economic strategy that has developed over the past 20 years. The foundation of this strategy is the understanding that the economy is inextricably linked to the natural environment, as a critical part of the economy itself. The current definition of a green economy is a specific pathway for economic development, i.e., creating new green industries, generating new demand for products and services, and fostering a new culture of consumption among citizens (Iskakov et al., 2021, pp. 62–69). The term was initially used in a 1989 report entitled *Blueprint for a Green Economy*, written by a group of economists for the UK Government (Tănasie et al., 2022). A green economy is an alternative method of developing economies in a way that provides better economic outcomes while reducing potential environmental risks. A green economy is closely related to sustainable development, since both have the same ultimate objective: to create sustainable economic development. In fact, a green economy is based upon the principles of sustainable development in order to achieve its objectives, and therefore offers a wide variety of ways to implement a green economy, with a focus on preserving the natural balance and promoting sustainable lifestyles. Basically, a green economy is an economy that minimizes environmental risks and ecological deficits, and aims for sustainable development, with no degradation of the natural environment, by switching to a low-carbon and resource-efficient model (Zvarych et al., 2022).

This represents a major change in how we think about development and growth, one that will enhance human well-being and the natural environment, while increasing both environmental and economic sustainability (Zhang et al., 2022). This economic model grew out of the need to find solutions for measuring and producing energy, building construction, tourism, and investment flows. It provides a macroeconomic framework for generating sustainable economic growth, with a focus on investments, jobs, and skills. A green economy is characterized by several key principles: the

principle of well-being, enabling all people to produce and enjoy prosperity, with a focus on developing wealth that supports such well-being, and the principle of equity, which supports intergenerational fairness. As such, a green economy is an inclusive, non-discriminatory economy that allows all people to participate in decision-making processes, benefits, and costs, while preventing a small group from monopolizing them. Also, a green economy includes the principles of efficiency and sufficiency by supporting strategic consumption and production, focusing on conserving resources and biodiversity using a circular approach, and by adopting new forms of economic development that address the problem of producing prosperity within the planet's ecological limitations. A green economy suggests that economic growth and the ecosystem can complement each other, so a green economy is consistent with the larger framework of sustainable development, which includes three aspects of development: economic, social, and environmental (Ocampo, 2011).

Initiatives that will help Iraq transition to a green economy include water desalination plants, waste treatment facilities, the implementation of modern irrigation systems along with the lining of irrigation canals, the development of wind and solar power generation, and the expansion of railway networks and electrical infrastructure. Iraq's transition to a green economy can be measured using different indicators, including gross domestic product (GDP) and the contribution of agriculture to its growth. Therefore, the purpose of this research is to measure how far Iraq has progressed towards becoming a green economy, and how much a green economy contributes to sustainable development programs by measuring GDP. In addition, the Sustainable Development Goals create a true link between the environmental system and the economic system. They also highlight the importance of transitioning to a green economy, a fundamental change toward more sustainable forms of production and consumption (Söderholm, 2020).

1.1. Research Significance

The importance of this study comes from the need for all countries (both developed and developing) to rapidly transition their economies from "brown" to "green." This transition is needed to reduce some of the negative effects that are typically associated with "brown economies," while also promoting the economic, social, and environmental components of sustainable development.

1.2. Research Problem

Traditional economic models cause negative impacts on the environment, society, and economy, such as the accumulation of pollutants in the atmosphere, water bodies, and soils used for agriculture, in addition to the creation of climate change and global warming. There are many problems facing the Iraqi agricultural sector in achieving sustainable development, one of the main ones being the loss of water resources. According to the green economy concept, economic growth and the protection of natural systems can be pursued together.

1.3. Research Hypothesis

This study proposes that the transformation of the structure and methods of agricultural production, as well as the transition from present-day consumption patterns to more sustainable consumption practices, could be achieved through the development of a green economy.

1.4. Research Objective

This study was conducted with the purpose of exploring the relationship between the green economy and achieving sustainable agricultural development in Iraq. The analysis focuses on how the agricultural sector contributes to the GDP of Iraq. In addition, this study defines the green economy, examines the potential application of the green economy toward promoting the sustainability of economic resources, and evaluates the effect of the green economy on Iraq's GDP during the years 1997 through 2023.

1.5. Theoretical Framework

GDP is a measure of the total economic activity occurring during a given time frame. It measures the monetary value of all final goods and services produced. GDP was created in the 1930s to help policy makers determine whether their country had recovered from the Great Depression. Since then, GDP has been considered the primary indicator of economic and social progress. However, GDP does

not differentiate between "bad" spending and "good" spending. Additionally, GDP does not take into account activities that do not have a price associated with them but provide value to society. Examples include volunteer work, raising children at home, and public investments made in education and research (Cha, 2013).

GDP is calculated using four components: consumption, investment, government spending, and net exports (exports minus imports). The formula for calculating GDP is GDP = $C + I + G + (E - M)$. This formula provides the monetary value of all goods and services purchased by individuals, companies, governments, and foreign entities within national borders. Although GDP includes many areas of economic activity, it excludes many areas of importance to both the economy and society, one example being the distribution of wealth or income. Also, GDP includes all economic activity that takes place within a nation's borders (Coyle, 2020).

On the other hand, a green economy is a knowledge-based economy that impacts society and the larger economic system. If these areas are ignored, then there may be negative consequences for the well-being of the population and the overall potential of a nation. So far, no nation has completely transitioned its economy to a green economy. However, nations with high levels of development have shown greater acceptance of environmentally friendly technologies and have continuously monitored compliance with standards designed to facilitate such a transition (Yushchenko et al., 2019). Each year there are increasing opportunities for nations to adopt cutting-edge technologies and create a green economy. However, the success of such efforts is largely dependent upon a nation's level of economic development. Nations with high levels of development (i.e., high GDP per capita) are more likely to implement environmental conservation programs, while developing nations and those with low standards of living tend to be slower to adopt such new technologies.

There are several challenges experienced by developing nations in terms of implementing environmentally friendly technologies. Some of these challenges include a reluctance on the part of government officials and corporate leaders to change technologies or invest in environmental preservation. Additionally, development in these areas is often based on models that contribute directly to environmental degradation. Finally, many of these areas also lack long-term strategic plans that address the adverse effects of environmental degradation (Mikhno et al., 2021, pp. 99–113). While the green economy represents an important policy framework for promoting sustainable development, it still experiences tension and limitations related to defining what constitutes a green economy and the discussions that surround it. Making a transition towards a green economy requires strong economic and environmental measurements; however, currently available methodologies for conducting such measurements are still evolving and often suffer from a lack of reliable data or exhibit inconsistencies with established definitions. To overcome some of these limitations, four recommendations for improving the measurement of the transition toward a green economy can be used so that it can regain its relevance in relation to emerging sustainable development goals (Georgeson et al., 2017). The hierarchy of these concepts is shown in Figure 1.

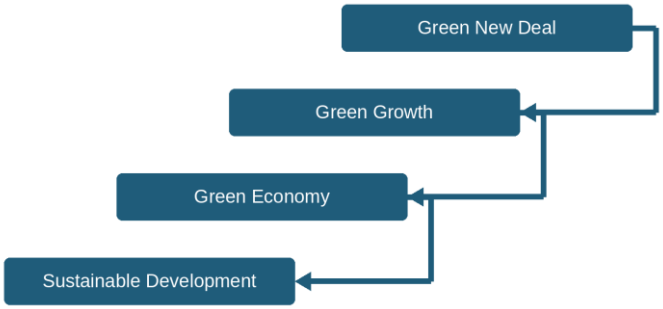


Figure 1. Hierarchy of Green Economy Concepts

Source: Redrawn from the original manuscript, based on ten Brink et al. (2012) and Georgeson et al. (2017)

Accordingly, the "Green New Deal" does not represent a theoretical concept separate from the green economy. Rather, it serves as an operational and investment instrument through which Iraq,

particularly its agricultural sector, can transition from a traditional economy reliant on fossil fuels and chemical fertilizers toward a sustainable, green agricultural economy based on resource efficiency and the recycling of agricultural waste.

2. Method

2.1. Research Approach and Data

The study utilizes both quantitative and qualitative analyses to meet the research goals. It uses different mathematical and statistical models to examine time-series data from 1997 through 2023, so that it can project how much the agricultural sector will contribute to Iraq's GDP. Data were obtained from the Ministry of Planning/Central Statistical Organization (Central Statistical Organization, n.d.) and analyzed using the EViews statistical software and Microsoft Excel.

2.2. Model Specification

An econometric model was formulated to identify the impact of the agricultural sector's contribution (the independent variable) on GDP (the dependent variable). This involves estimating the model's parameters, evaluating these estimates for predictive purposes, and finally testing the model's forecasting capability. Other factors affecting GDP are assumed to be constant. The model is expressed as follows:

$$Y = \beta 0 + \beta 1X1 + ei \quad (1)$$

where Y is the dependent variable (GDP), X_1 is the independent variable (contribution of the agricultural sector), β_0 is the constant term of the GDP function, and β_1 is the coefficient of the independent variable (X_1), that is, the agricultural sector.

3. Results and Discussion

3.1. Contribution of the Agricultural Sector to GDP

Economic development in Iraq has led to improved living standards for individuals; Iraq's GDP rose from 15,093,144 million dinars to 252,654,600 million dinars between 1997 and 2023 (Central Statistical Organization, n.d.). Despite this economic growth, the development of the ecosystem has lagged behind and has been insufficient to keep pace with the economic expansion, thereby acting as a limiting factor for sustainable development. In addition, although the agricultural sector's total contribution to GDP has increased, its relative share of total GDP has declined from 8.5% to 3.3%. While the agricultural sector's contribution has increased in total (absolute) value between 1997 and 2023, its percentage share has decreased, as indicated by the data presented in Table 1.

Table 1. Agricultural Sector Contributions to Iraq's GDP, 1997–2023 (Million Dinars)

Year	GDP	Agri. Sector	%	Year	GDP	Agri. Sector	%
1997	15,093,144.0	1,276,367.1	8.5	2011	217,327,107.0	9,918,316.8	4.6
1998	17,125,847.5	1,868,379.8	10.9	2012	254,225,490.7	10,484,949.3	4.1
1999	34,464,012.6	2,482,616.5	7.2	2013	273,587,529.2	13,045,856.4	4.8
2000	50,213,699.9	2,327,277.2	4.6	2014	266,332,655.1	13,128,622.6	4.9
2001	41,314,568.5	2,863,495.0	6.9	2015	194,680,971.8	8,160,769.7	4.2
2002	41,022,927.4	3,512,658.6	8.6	2016	196,924,141.7	7,832,046.9	4.0
2003	29,585,788.6	2,486,865.5	8.4	2017	221,665,709.5	6,598,384.8	3.0
2004	53,235,358.7	3,693,768.0	6.9	2018	268,918,874.0	7,572,265.1	2.8
2005	73,533,598.6	5,064,158.0	6.9	2019	276,157,867.6	10,411,174.4	3.8
2006	95,587,954.8	5,568,985.7	5.8	2020	215,661,516.5	13,130,927.0	6.1
2007	111,455,813.0	5,494,212.4	4.9	2021	301,152,818.8	9,970,509.0	3.3
2008	157,026,062.0	6,042,017.7	3.8	2022	383,064,152.3	10,922,787.7	2.9
2009	130,643,200.0	6,832,552.1	5.2	2023	252,654,600.0	8,337,601.8	3.3
2010	162,064,566.0	8,366,232.4	5.2				

Source: Prepared by the researchers based on data obtained from the Ministry of Planning/Central Statistical Organization.

3.2. Descriptive Statistics

The descriptive statistics derived from the analysis are presented in Table 2.

Table 2. Descriptive Statistical Results for the Gross Domestic Product and the Agricultural Sector in Iraq

Statistic	GDP	Agri. Sector
Mean	160,545,184.3	6,940,511
Median	162,064,565.5	6,832,552
Maximum	383,064,152.3	13,130,927
Minimum	15,093,144	1,276,367
Std. Dev.	105,645,209.2	3,643,825
Skewness	0.138885	0.138783
Kurtosis	1.865995	1.932903
Jarque–Bera	1.533515	1.367706
Probability	0.464517	0.504669
Sum	4,334,719,976.1	187,393,797.5
Observations	27	27

Source: Compiled by the researchers based on analysis results using the EViews program.

The mean GDP for the period under study (1997–2023) was approximately 160,545,184.3 million dinars, with a median value of 162,064,565.5. The highest recorded GDP was 383,064,152.3 in 2022, while the lowest was 15,093,144 in 1997. This indicates an overall upward trend in GDP, albeit with year-to-year fluctuations, variations attributable to factors such as the country's political situation, wars, economic sanctions, and other related circumstances. The standard deviation was 105,645,209.2, and the skewness coefficient was approximately 0.138885, indicating a right-skewed frequency distribution curve. The kurtosis coefficient was 1.865995, as shown in Figure 2.

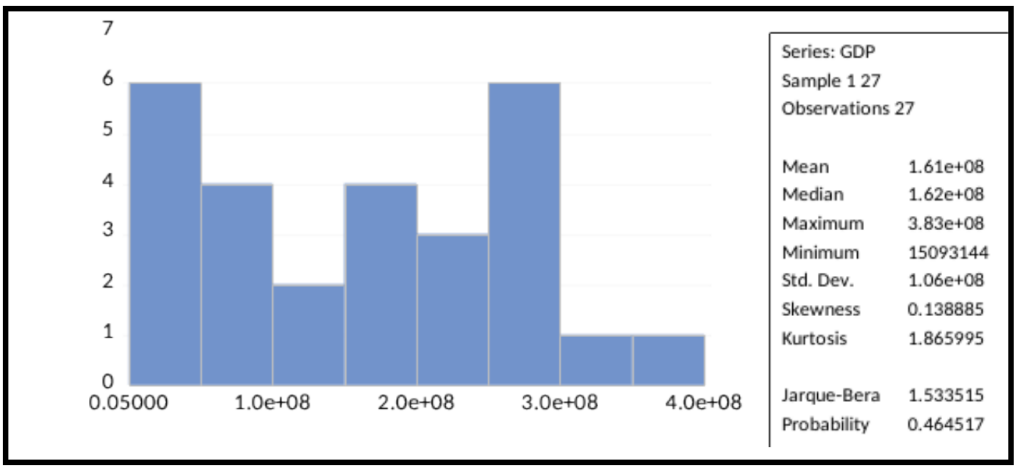


Figure 2. Frequency Distribution Curve for the Gross Domestic Product (GDP) Variable

Source: Prepared by the researchers based on analysis results from the EViews program.

The mean value of the agricultural sector for the period from 1997 through 2023 was around 6,940,511 million dinars, and its median was 6,832,552. The highest value recorded in the agricultural sector was 13,130,927 in 2020, and the smallest was 1,276,367 in 1997. Therefore, the agricultural sector as a whole has experienced an increasing trend over time; however, there are many yearly fluctuations in the agricultural sector due to various reasons, including the amount of water available (inflow amounts) and the types of agricultural programs implemented. The standard deviation was 3,643,825. The frequency distribution curve is right-skewed, with a skewness coefficient of approximately 0.138783, and the kurtosis coefficient is 1.932903, as shown in Figure 3.

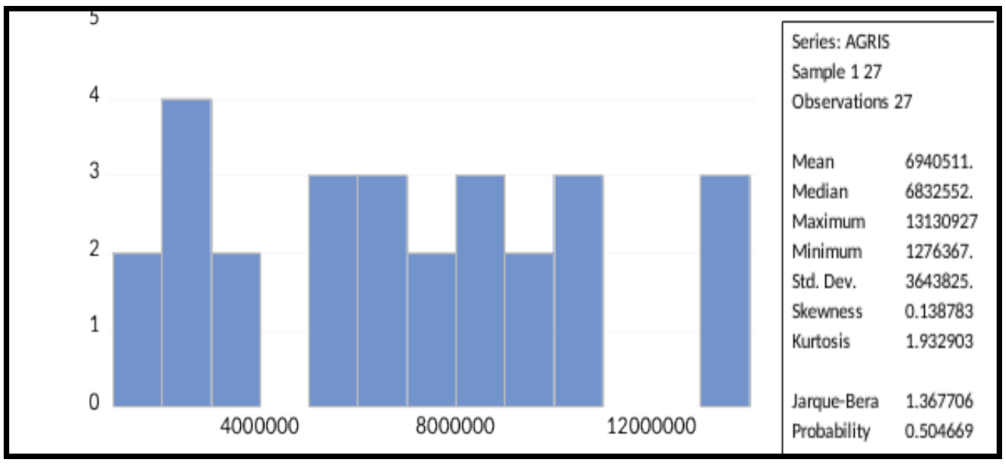


Figure 3. Frequency Distribution Curve for the Agricultural Sector Variable

Source: Prepared by the researchers based on analysis results from the EViews program.

3.3. Normality Test and Regression Estimation

To verify how closely the data approximate a normal distribution, the decision rule for accepting the null hypothesis (that the data follow a normal distribution) is that the test's *p*-value must be greater than 0.05. Table 2 shows that all variables under study follow a normal distribution; the *p*-values of the Jarque–Bera test for the agricultural sector and GDP are 0.504669 and 0.464517, respectively, both greater than 0.05, indicating no issues regarding the normal distribution assumption. Furthermore, a regression model was estimated based on a simple linear regression equation, as presented in Table 3.

Table 3. Results of the Simple Linear Regression Model Analysis for the Gross Domestic Product (GDP) and the Agricultural Sector

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Agricultural sector (X)	25.87549	2.615719	9.892305	0.0000
C	−19,043,967	20,422,118	−0.932517	0.3600
R-squared	0.796513	Mean dependent var	160,545,184.3	
Adjusted R-squared	0.788373	S.D. dependent var	105,645,209.2	
S.E. of regression	48,599,890	Akaike info criterion	38.30733	
Sum squared resid	5.90E+16	Schwarz criterion	38.40332	
Log likelihood	−515.1489	Hannan–Quinn criter.	38.33587	
F-statistic	97.85770	Durbin–Watson stat	1.226221	
Prob(*F*-statistic)	0.000000			

Source: Prepared by the researchers based on the analysis results from the EViews program.

Table 3 shows that the constant term has a negative value of −19,043,967, which represents the value of GDP when the independent variable (the agricultural sector) is equal to zero. Furthermore, the coefficient of the independent variable (the agricultural sector) is positive (25.87549), indicating a direct (positive) relationship between GDP and the contribution of the agricultural sector. The *p*-value is 0.0000, which is less than 0.05 (at the 1% significance level), implying that GDP is positively influenced by the agricultural sector at the 99% confidence level; that is, as the value of the agricultural sector increases, the value of GDP also increases.

The correlation analysis reveals a significant positive relationship between GDP and the agricultural sector, with an R^2 value of 0.796 and an adjusted R^2 value of 0.788. This indicates that 79% of the variations and fluctuations in GDP are explained by the independent variable (the agricultural sector), while the remaining 21% are attributable to variables not included in the model, the effects of which are captured by the stochastic error term (e_i) incorporated into the model. Additionally, the *F*-statistic was 97.857 with a *p*-value of 0.0000. These two statistics indicate that the overall regression model is statistically significant and that the independent variable (agricultural sector) has a large effect on the dependent variable (GDP).

One of the greatest concerns in estimating a regression model is the potential for autocorrelation of the error terms. Autocorrelation occurs when the error term for each time period is correlated with the error term for the previous time period, and it affects both the standard errors of each estimate and the validity of any statistical tests performed on the estimates. To determine whether there is autocorrelation of the errors, the Durbin–Watson test was used: the *d*-statistic calculated from the linear regression model is compared with the critical values from the Durbin–Watson table. For this study, the calculated *d*-statistic was 1.23. Using the Durbin–Watson critical values for a significance level of 0.05, with $k = 1$ and $n = 27$, the calculated *d*-statistic lies in the "zone of indecision," which means that there is not enough evidence to say whether or not autocorrelation is present in the error terms. Given these findings, the relationship between the dependent variable (GDP) and the independent variable (agricultural sector) is estimated using the following equation:

$$GDP = -19{,}043{,}967 + 25.87549X + ei \quad (2)$$

3.4. Forecasting GDP and the Agricultural Sector to 2030

Equation (2) allows GDP to be predicted: each time the agricultural sector contributes another one million dinars (*X*), GDP is expected to grow by 25.87549 million dinars. In addition to projecting future values for a specific year, such as 2030, this same process, or the projection capabilities within Excel, can also be utilized to estimate values for other future years. The predicted values for 2024–2030 are presented in Table 4, while the actual values for 1997–2023 are presented in Table 1.

Table 4. Predicted Values of the Gross Domestic Product (GDP) and the Agricultural Sector's Contribution, 2024–2030 (Million Dinars)

Year	GDP	Agri. Sector	%
2024	396,555,635.1	17,509,695.65	4.4
2025	411,985,787.2	18,148,507.16	4.4
2026	427,415,939.3	18,787,318.67	4.4
2027	442,846,091.4	19,426,130.18	4.4
2028	458,276,243.5	20,064,941.69	4.4
2029	473,706,395.6	20,703,753.20	4.4
2030	489,136,547.7	21,342,564.71	4.4

Source: Prepared by the researchers based on data obtained from the Ministry of Planning/Central Statistical Organization, as well as results from Excel.

4. Conclusion

The results of this study indicate that the implementation of a green economy can contribute to a transition toward a fair and sustainable economy, while also fostering the rational use of economic resources and environmental sustainability. The green economy represents a bottom-up approach, rather than a top-down economic model, as it is shaped by local, national, and regional needs. The analysis of the 1997–2023 period shows a positive and significant relationship between the contribution of the agricultural sector and Iraq's GDP: although the agricultural sector's absolute contribution increased, its share of GDP declined from 8.5% to 3.3%, and the agricultural sector explains about 79% of the variation in GDP, so these two variables exerted a significant influence on each other throughout the study period. Because the agricultural sector is the largest consumer of water in Iraq, the only viable option for rationalizing water use is to adopt environmentally sustainable strategies for managing irrigated agriculture and enhancing productivity. It is also essential to adopt new models for sustainable agricultural development and for official authorities to provide a comprehensive agricultural database, which will help generate outcomes that contribute to achieving a sustainable green economy. Finally, efforts should be directed toward creating an investment climate conducive to a transition toward a green economy by refining and improving the performance of agricultural economic policies.

Data Availability

The data used in this study were obtained from the Ministry of Planning/Central Statistical Organization of Iraq and are available from the corresponding author on reasonable request.

Author Contributions

Anwar Mohsen Sagab and Rahim Hadi Nasser Al-Aqabi contributed equally to the conceptualization, data collection, data analysis, manuscript preparation, and revision of this article. Both authors have read and approved the final version of the manuscript.

Conflicts of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

Funding Statement

This research was conducted independently by the researchers without any financial support or funding from external institutions or organizations.

Acknowledgments

The authors would like to thank all those who have helped in the preparation of this article.

Supplementary Materials

This study does not include any supplementary materials.

Declaration on AI Use

The authors declare that no artificial intelligence (AI) or AI-assisted tools were used to generate scientific content, analyses, or conclusions in this manuscript.

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