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ARTICLE

Impact of Agricultural Public Finance Instruments on the Agricultural Sector's Contribution to GDP: Empirical Evidence from Iraq

Hanan Shaheen Hussein [1], *Samah Salih Ali* [2], *Mahmood Suwaid* [3], *Faisal Ghazi Faisal* [4*], *Muhannad Khalifa Obed* [2], *Muhannad Khamis Abed* [2], *Taha Ayad Saad* [5]

[1] *Department of Accounting, College of Administration and Economics, University of Fallujah, Fallujah 31002, Iraq*

[2] *Department of Economics, College of Administration and Economics, University of Fallujah, Fallujah 31002, Iraq*

[3] *Department of Finance and Banking Sciences, College of Financial and Administrative Sciences, University of Al Maarif, Ramadi 31001, Iraq*

[4] *Department of Finance and Banking, Al-Idrisi University College, Ramadi 31001, Iraq*

[5] *Department of Business Administration, Al-Nukhba University College, Baghdad 10001, Iraq*

ABSTRACT

This study investigates the experimental impact of agricultural public finance tools (government agricultural investment spending and government agricultural loans) on the contribution of the agricultural sector to the Gross Domestic Product (GDP) in Iraq, using quarterly data for the period 2008–2024, through the use of the Autoregressive Distributed Lag (ARDL) model. The results of the study showed a statistically significant positive effect of government agricultural investment spending on agricultural GDP. The results also indicated a statistically significant positive effect of government agricultural loans on agricultural GDP. The study included important control variables such as rainfall rate, agricultural labor force size, and inflation rate, which showed statistically significant effects on agricultural GDP, highlighting the importance of climatic conditions, labor availability, and overall stability in supporting the agricultural sector's performance to increase its contribution to the Iraqi GDP. The study's

*CORRESPONDING AUTHOR:
Faisal Ghazi Faisal, Department of Finance and Banking, Al-Idrisi University College, Ramadi 31001, Iraq; Email: faisal.ghazi@idrisi.edu.iq

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findings also revealed a moderate speed of adjustment towards long-term equilibrium (with an error correction coefficient of −0.4315), reflecting a partial response of the agricultural sector to government financial policies. The study recommends improving public investment planning, reforming agricultural loan distribution systems, and enhancing institutional frameworks to ensure the effective use of government financial interventions and support sustainable growth in the Iraqi agricultural sector.

Keywords: Agricultural Investment Spending; Agricultural Loans; Agricultural GDP; ARDL Model; Iraq

1. Introduction

The agricultural sector is one of the sectors that plays an important role in the economic and social development of any country, as it is the primary sector for providing food and securing the basic needs of the population. The impact of the agricultural sector is not limited to meeting the needs of the local market only; it also supports the food industry and provides job opportunities, especially in rural areas where residents primarily rely on agricultural activities [1]. Moreover, this sector plays a significant role in achieving balance in the trade balance, as agricultural exports represent a major source of foreign currency and also help address the trade deficit [2]. Additionally, the agricultural sector is important in facing climate change and environmental pressures by adopting agricultural systems that contribute to the protection of natural resources [3].

The relationship between public spending and the contribution of the agricultural sector to GDP is important in analyzing economic development, especially in developing countries where a large portion of the population relies on agriculture as a primary source of income and livelihood [4]. Public spending is one of the central tools that stimulate aggregate demand; thus, an increase in government spending in productive sectors such as agriculture leads to increased production, higher employment levels, and GDP growth. Additionally, one unit of government spending creates a multiplier effect on GDP, especially if directed toward labor-intensive sectors linked to broad production sectors, resulting in an increased contribution of the agricultural sector to GDP [5].

In Iraq, the agricultural sector faces many significant challenges that affect its contribution to the gross domestic product, despite the available agricultural potential, such as arable land. Examples of the challenges facing the agricultural sector in Iraq include the deterioration of agricultural infrastructure and the weak use of modern technologies in agriculture. Furthermore, mismanagement and weak revenue collection have made Iraq one of the countries with high corruption rates according to the Corruption Perceptions Index issued by Transparency International [6].

In light of the above, and in order to enhance the agricultural sector's ability to face these challenges, government investment spending in the agricultural sector is of utmost importance. If used to support research and innovation in various agricultural fields, modernize infrastructure and agricultural equipment, expand irrigation networks, and improve road and transportation networks in rural areas [7].

In this context, government-provided agricultural loans to the agricultural sector play a complementary role in enhancing its ability to face challenges by increasing productivity and improving crop quality [8]. This is achieved by financially supporting farmers to purchase modern agricultural supplies such as machinery, fertilizers, and seeds.

Therefore, the research problem arose to determine the extent of the impact of government investment spending in agriculture and government agricultural loans on the contribution of the agricultural sector to the Iraqi GDP during the period 2008–2024.

Accordingly, this research aims to understand the impact of agricultural public finance tools (government agricultural investment spending and government agricultural loans) on the contribution of the agricultural sector to the Gross Domestic Product (GDP) in Iraq.

Based on the research problem and its aims, the research hypotheses are formulated below:

$\mathbf{H_1}$. *There is a statistically significant positive impact of government investment spending in the agricultural sector on the contribution of the agricultural sector to the Gross Domestic Product in Iraq during the study period.*

$\mathbf{H_2}$. *Government agricultural loans have a significant impact on the contribution of the agricultural sector to Iraq's Gross Domestic Product during the study period.*

2. Literature Review

Many studies have shown interest in analyzing the impact of agricultural public finance tools (public spending and public loans) on the contribution of the agricultural sector to GDP, due to the importance of this sector in increasing economic growth and achieving food security, especially in developing countries. The literature review aims to benefit from it in supporting the current study, while also identifying the research gap that this study seeks to address.

A study by Armas et al., conducted in Indonesia, showed that government spending directed towards the agricultural sector had a direct and significant positive impact on increasing the contribution of this sector to GDP, through improving productivity and enhancing value-added, particularly through investments in agricultural infrastructure and technical support, which had a multiplier effect [9]. Similarly, a study by Jaroensathapornkul analyzed the dynamic relationship between public agricultural spending and the contribution of the agricultural sector to GDP in five ASEAN countries, and the results indicated a long-term integration relationship and a positive and significant impact of public spending on the agricultural sector's contribution to GDP [10]. A study by Ngobeni & Muchopa in South Africa found that agricultural government spending had a positive impact on the value of agricultural production in the long term, confirming the importance of directing public resources to support this vital sector and stimulate its growth [11]. A study by Hossain et al. analyzed the impact of agricultural financing in Bangladesh, and the results showed a positive and significant relationship between agricultural financing and the contribution of the agricultural sector to GDP in both the short and long term [12]. Supporting the role of government spending, a study by Ahmed et al. in Pakistan, covering the period 1971–2014, found that government agricultural spending had a positive and significant impact on the growth of agricultural GDP [13]. In contrast, a study by Victor et al., conducted in Nigeria, indicated that government spending did not have a significant impact on the agricultural sector's contribution to GDP, while agricultural loans had a positive and significant effect in supporting this sector's contribution [14]. In a study conducted by Roy et al., the relationship between agricultural loans and agricultural GDP in Bangladesh for the period 1976–2018 was analyzed. The study's results showed that agricultural loans have a positive and significant impact on increasing agricultural GDP by enabling farmers to obtain the necessary financing to enhance productivity and expand agricultural activities [15]. These results are consistent with the findings of Ozdemir's study, which analyzed the relationship between agricultural loans and agricultural value added in a sample that included 53 developing and developed countries during the period 2000–2018. The results concluded that there is a positive and statistically significant relationship between agricultural loans and agricultural value added, where a 1% increase in agricultural loans leads to a 0.19% increase in agricultural value added. This reflects the importance of agricultural loans as an important and effective tool for stimulating agricultural production, and thus increasing the contribution of agriculture to the gross domestic product [16].

Despite the diversity of these studies and their coverage of several developing countries, there is a clear research gap in the Iraqi context, as the relationship between agricultural public finance tools—specifically government agricultural investment spending and government agricultural loans—and achieving an effective contribution of the agricultural sector to GDP has not received the in-depth research attention it deserves. Additionally, most previous studies focused on only one tool or relied on annual data without a clear distinction between short-term and long-term effects. Therefore, this study aims to fill this gap by jointly and comprehensively analyzing the impact of both government agricultural spending and agricultural loans on the contribution of the agricultural sector to GDP in Iraq using quarterly data for the period 2008–2024, employing an ARDL model capable of distinguishing between different temporal effects and verifying the long-term equilibrium relationship, thus providing a new analytical and practical dimension that contributes to supporting national agricultural economic policies.

3. Theoretical Framework

Fiscal policy is one of the most important driving forces of economic activity in any country, as its various tools, such as public spending and loans, are used to influence overall demand levels and achieve economic stability and growth [17]. In the agricultural context, fiscal policy assumes added importance, particularly in developing economies where a significant portion of the population relies on agricultural activities as a primary source of income and livelihood [18].

Agricultural fiscal policy is based on the economic assumption that state intervention through targeted financial tools (such as government agricultural investment spending or agricultural loans) can enhance the added value of the agricultural sector and improve its contribution to GDP [19]. Economic literature shows that increasing financial resources in this sector creates what is known as the ”agricultural multiplier effect,” which expresses the ability of government spending or agricultural financing to stimulate activities related to agriculture, such as transportation, storage, and marketing, thereby increasing total output [5].

The effectiveness of fiscal policy in this area depends on several factors, including the efficiency of resource allocation, the effectiveness of monitoring and evaluation tools, and the institutional environment that manages these tools. In countries suffering from weak governance or widespread financial corruption, the efficiency of agricultural spending declines. Directing public spending towards agricultural infrastructure projects (such as irrigation, rural transport, mechanization, and agricultural research) is considered more effective than unproductive support. Government agricultural loans are used to stimulate private investment in agriculture, particularly among small farmers who cannot access commercial financing [20]. Recent studies show that directing loans towards productive purposes leads to a noticeable increase in agricultural output [15].

In the case of Iraq, there is a chronic gap between the large agricultural potential (in terms of land, water, and labor) and the actual contribution of agriculture to the gross domestic product, which has remained relatively modest [21]. This is attributed to multiple factors, including low effectiveness of public agricultural spending, poor management of agricultural loans, deteriorating infrastructure, and the impact of climate change and inflation on production. Here, the role of fiscal policy tools emerges as a key determinant in enhancing the performance of this sector, provided they are integrated with effective institutional and regulatory reforms [22].

In light of this, the importance of the current study becomes clear in its effort to measure the impact of both government agricultural investment spending and government agricultural loans on the contribution of the agricultural sector to the GDP in Iraq, using the ARDL model, which allows for the distinction between short-term and long-term effects, and analyzing the dynamics of the relationship between the variables in light of the characteristics of the Iraqi economy and its fluctuations during the period (2008–2024).

4. Methodology

The study aims to measure and analyze the impact of agricultural public finance tools on the contribution of the agricultural sector to the gross domestic product in the short and long term in Iraq. To achieve this, annual time series data from 2008 to 2024 were used, and the annual time series data were converted to quarterly data in their original form to enable the application of standard economic methods, which will provide more accurate and unbiased results if the time series is longer [23]. The model design uses the contribution of the agricultural sector to GDP as the dependent variable (Y), government spending on agricultural investment (X1), and government agricultural loans (X2) as independent variables, while average rainfall (X3), agricultural labor force (X4), and inflation (X5) are used as control variables, as shown in **Table 1**.

Table 1. Research Variables.

Variable	Description	Variable type	Source
Y	Value of agriculture's contribution to GDP	dependent variable	Central Bank of Iraq [24]
X1	Government agricultural investment spending	Independent variables	
X2	Government agricultural loans		
X3	Average Rainfall	Control Variables	Arab Organization for Agricultural Development [25]
X4	Agricultural Labor Force		
X5	Inflation		Central Bank of Iraq [24]

For this investigation, the Autoregressive Distributed Lag Model (ARDL) was selected because of its adaptability and remarkable capacity to manage the dynamic and multifaceted character of economic data. It does not require equal degrees of integration and permits the analysis of variables with different integration orders (I(0) and I(1)). By integrating an error correction model, it clearly distinguishes between short-term and long-term effects [26]. Furthermore, since Iraq's political and economic performance fluctuated during the study period, this model was selected. This makes it a good model for analyzing data that could be impacted by external shocks or structural changes, particularly when using structural stability tests like CUSUM and CUSUMSQ.

5. Results and Discussion

5.1. Unit Root Test

The Phillips-Perron (PP) test was used to examine the presence of a unit root in the main variables of the model [27], as shown in **Table 2**.

Table 2. Results of the Stationarity Test of Variables According to the PP Method.

				At Level			
		Y	*X1*	*X2*	*X3*	*X4*	*X5*
With Constant	Prob.	0.1493 n0	0.0351 **	0.17 n0	0.1769 n0	0.5214 n0	0.0436 **
With Constant & Trend	Prob.	0.4247 n0	0.1228 n0	0.8154 n0	0.3037 n0	0.677 n0	0.3667 n0
Without Constant & Trend	Prob.	0.6161 n0	0.0612 *	0.8682 n0	0.2986 n0	0.423 n0	0.0099 ***
				At First Difference			
		d(Y)	*d(X1)*	*d(X2)*	*X3*	*X4*	*X5*
With Constant	Prob.	0.0000 ***	0.0000 ***	0.0000 ***	0.0000 ***	0.0000 ***	0.0000 ***
With Constant & Trend	Prob.	0.0000 ***	0.0000 ***	0.0000 ***	0.0000 ***	0.0000 ***	0.0000 ***
Without Constant & Trend	Prob.	0.0000 ***	0.0000 ***	0.0000 ***	0.0000 ***	0.0000 ***	0.0000 ***

Note: (*) Significant at the 10%; (**) Significant at the 5%; (***) Significant at the 1% and (no) Not Significant.

The results in **Table 2** indicate that most of the variables in the model are non-stationary at the level, except for the variables X1 and X5, which showed partial significance. After taking the first difference, all variables became stationary, as the results were significant at the 1% level in all cases, indicating that they are integrated of order one I(1). Based on these results, the best analysis model is the Autoregressive Distributed Lag (ARDL) model due to its ability to handle a mix of I(0) and I(1) variables and effectively estimate both short-term and long-term relationships among them.

5.2. Preliminary Estimation of the Model

Testing the optimal lag periods for the first differences of the variable values in the model based on the AIC criterion, as shown in **Table 3**.

Table 3. Preliminary estimation of the (ARDL) model.

Dependent Variable: (Y)

Method: ARDL
Maximum dependent lags: 4 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Selected Model: ARDL (3, 4, 4, 4, 4, 4)

Variable	*Coefficient*	*Std. Error*	*t-Statistic*	*Prob.**
Y(−1)	1.108326	0.287311	3.85758	0.0009
Y(−2)	−0.98458	0.230841	−4.2652	0.0003
Y(−3)	0.444709	0.104031	4.274757	0.0003
X1	−5.36682	1.960674	−2.73723	0.012
X1(−1)	−0.25642	1.039989	−0.24656	0.8075
X1(−2)	0.842691	1.151744	0.731665	0.4721
X1(−3)	−1.42309	1.156421	−1.2306	0.2315
X1(−4)	−3.08902	1.111326	−2.77958	0.0109
X2	−6.44247	2.660969	−2.4211	0.0242
X2(−1)	0.469856	3.219719	0.145931	0.8853
X2(−2)	3.119296	3.656223	0.853147	0.4028
X2(−3)	−7.07031	3.712198	−1.90462	0.07
X2(−4)	9.015194	3.110478	2.898331	0.0083
X3	46,913.3	11,144.74	4.209456	0.0004
X3(−1)	−24,364.3	14,117.63	−1.72581	0.0984
X3(−2)	10,650.94	15,807.56	0.673788	0.5075
X3(−3)	15,358.14	14,754.4	1.040919	0.3092
X3(−4)	−29,270.8	10,740.04	−2.72539	0.0124
X4	−7,566.13	3,510.272	−2.15543	0.0423
X4(−1)	1,338.793	4,909.646	0.272686	0.7876
X4(−2)	1,360.886	5,729.097	0.237539	0.8144
X4(−3)	−4,429.58	5,822.533	−0.76076	0.4549
X4(−4)	11,405.54	5,088.602	2.24139	0.0354
X5	2,309,070	693,261.6	3.330733	0.003
X5(−1)	-846,784	986,157.8	−0.85867	0.3998
X5(−2)	260,174.7	1,163,055	0.223699	0.8251
X5(−3)	847,258.2	1,158,905	0.731085	0.4724
X5(−4)	−1,471,359	790,699.1	−1.86083	0.0762
C	60,041,844	20,220,779	2.969314	0.0071
R-squared	0.999989	Mean dependent var		9,501,696
Adjusted R-squared	0.999971	S.D. dependent var		2,140,627
S.E. of regression	11,606.51	Akaike info criterion		21.81538
Sum squared resid	2.96E+09	Schwarz criterion		23.16495
Log likelihood	−626.369	Hannan-Quinn criter.		22.34429
F-statistic	53,708.34	Durbin-Watson stat		2.800483
Prob(F-statistic)	0			

The results of **Table 3** indicate that the model explains approximately 99.99% of the variations in Y, demonstrating a high fit of the model. The model also shows very strong statistical significance. To ensure the accuracy of the ARDL estimation, the optimal lag length for all variables included in the model was determined using the Akaike Information Criterion (AIC), with the aim of selecting the most efficient model with the least information loss. The results of this test, shown in **Table 3**, indicate that the optimal model is ARDL (3,4,4,4,4,4), meaning that the contribution of the agricultural sector to GDP (Y) depends on three lags, while agricultural investment expenditure (X1), government agricultural loans (X2), rainfall rate (X3), agricultural labor (X4), and inflation (X5) each depend on four lags.

Adopting this optimal lag length allows the model to accurately distinguish between short-term and long-term effects, while also reducing the likelihood of misestimation caused by using inappropriate lag lengths.

5.3. Cointegration Test According to the Bounds Test

After determining the optimal lag periods for the estimated model, which are (3, 4, 4, 4, 4, 4), it is necessary to know whether there is a cointegration relationship between the independent variables and the dependent variable, as shown in **Table 4**.

Table 4. Results ARDL Bounds Test.

Test Statistic	**Value**	**K**
F-statistic	24.96421	5
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.03	3.13
5%	2.32	3.5
2.5%	2.6	3.84
1%	2.96	4.26

The Bounds Test showed that the F statistic value reached (24.96421), which is higher than the critical values at all levels of statistical significance (1%, 5%, 10%), indicating the rejection of the null hypothesis regarding the absence of a long-term relationship between the variables, and acceptance of the hypothesis of a significant equilibrium relationship in the long term.

5.4. Estimation of Short-Term and Long-Term Response and Error Correction Coefficient

After conducting stability tests and confirming the degree of integration of the time series, as well as ensuring the existence of a cointegration relationship between the independent variables and the dependent variable, that is, the existence of a long-term equilibrium relationship, it is now necessary to obtain the short-term and long-term estimates for the parameters of the estimated model and the error correction parameter, as shown in **Table 5**.

Table 5. Results ARDL Cointegrating And Long Run Form.

Dependent Variable: (Y)
Selected Model: ARDL(3, 4, 4, 4, 4, 4)
Sample: 2008Q1 2024Q4
Included observations: 61

Cointegrating Form				
Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
D(Y(−1))	0.539874	0.172129	3.136453	0.0048
D(Y(−2))	−0.444709	0.104031	−4.27476	0.0003
D(X1)	5.366824	1.960674	2.737234	0.012
D(X1(−1))	0.842691	1.151744	0.731665	0.4721
D(X1(−2))	1.42309	1.156421	1.230599	0.2315
D(X1(−3))	3.089021	1.111326	2.779581	0.0109
D(X2)	6.442471	2.660969	2.4211	0.0242
D(X2(−1))	3.119296	3.656223	0.853147	0.4028
D(X2(−2))	7.070311	3.712198	1.904616	0.07
D(X2(−3))	9.015194	3.110478	2.898331	0.0083
D(X3)	46,913.30343	11,144.74	4.209456	0.0004
D(X3(−1))	−10,650.94083	15,807.56	−0.67379	0.5075
D(X3(−2))	−15,358.13699	14,754.4	−1.04092	0.3092
D(X3(−3))	29,270.81483	10,740.04	2.725391	0.0124
D(X4)	−7,566.129068	3,510.272	−2.15543	0.0423
D(X4(−1))	−1,360.885883	5,729.097	−0.23754	0.8144
D(X4(−2))	4,429.576098	5,822.533	0.760764	0.4549
D(X4(−3))	−1,1405.5402	5,088.602	−2.24139	0.0354
D(X5)	2,309,069.663	693,261.6	3.330733	0.003
D(X5(−1))	−260,174.7103	1,163,055	0	0
D(X5(−2))	−847258.2299	1,158,905	0	0
D(X5(−3))	1,471,358.964	790,699.1	1.860833	0.0762
CointEq(−1)	−0.431548	0.121997	−3.53736	0.0019
Cointeq = Y - (21.5333*X1 + 2.1051*X2 + 44,693.0706*X3 + 4,888.2431 *X4 + 2,545,160.2906*X5 + 139,131,173.0642)				
Long Run Coefficients				
Variable	***Coefficient***	***Std. Error***	***t-Statistic***	***Prob.***
X1	21.533304	1.83903	11.70905	0
X2	2.105058	0.521846	4.03387	0.0006
X3	44,693.07065	2512.336	17.78945	0
X4	4,888.243119	923.9089	5.290828	0
X5	2,545,160.291	167,399.3	15.20413	0
C	139,131,173.1	11,782,191	11.8086	0

The results of the short-term model in **Table 5** indicate that some variables affecting the contribution of the agricultural sector to the GDP show their effects more quickly compared to others. It has been found that agricultural investment expenditure has a significant positive effect in the early periods, reflecting that increased government spending on agricultural infrastructure and production inputs directly translates into agricultural output growth in the short term. Likewise, government agricultural loans showed a positive and significant effect, but with varying significance across periods, indicating that the impact of these loans depends on how quickly they are directed toward productive uses.

As for the control variables, it was found that the rainfall rate has an immediate and clear effect in the short term, reflecting the agricultural sector's sensitivity to direct climatic conditions. In contrast, the results for agricultural labor showed that its effect varies between periods, which may be related more to the efficiency of labor utilization than to its total size. Inflation also had a significant effect in the short term, as it leads to an increase in the nominal value of agricultural production, even if it is not always accompanied by an improvement in real production.

Table 5 showed a long-term equilibrium relationship between government agricultural investment spending and government agricultural loans on the one hand, and the contribution of the agricultural sector to GDP in Iraq on the other hand. In addition, the results of the Error Correction Model (ECM) indicated that the correction coefficient was (-0.4315), which is statistically significant, confirming the existence of a long-term relationship between the dependent variable and the independent variables. It also shows that approximately 43.15% of the deviation is corrected within one quarter, indicating a moderate speed of adjustment and a return to the equilibrium path.

The model results indicate a statistically significant long-term and short-term relationship between agricultural GDP and several explanatory variables. In both the long and short terms, government agricultural investment spending (X1) showed a positive and significant impact on agricultural GDP. This finding is consistent with the results of the study by Ahmed et al [13] and the study by Jaroensathapornkul [10], reflecting the vital role of government investment policies in enhancing the agricultural sector's contribution to GDP. Thus, the validity of the first hypothesis was confirmed.

The results also support the second hypothesis, as the Government agricultural loans (X2) have shown a positive and significant impact on agricultural GDP in both the short and long term. This result is consistent with the findings of the study by Ozdemir [16] and the study by Roy et al [15], indicating the importance of these loans in supporting the Iraqi agricultural sector to increase its productivity and subsequently contribute to the national GDP.

As for the controlling variables, the average rainfall (X3) showed a positive and significant effect in both the short and long term, and this result is consistent with the findings of the study by Chandio et al [28], highlighting the importance of climatic conditions in influencing agricultural production and emphasizing the necessity of adopting strategies for managing climate risks. The agricultural workforce (X4) also exhibited a positive and significant effect on the contribution of the agricultural sector to GDP, a result that aligns with the findings of the study by Abdelgawwad & Kamal [29], where the researchers confirmed that the agricultural workforce is one of the key factors influencing agricultural growth, attributed to the vital role played by labor in supporting essential agricultural activities. Meanwhile, the results for inflation (X5) indicated a positive and significant effect, particularly in the long term, which is due to the specific nature of the Iraqi economic structure that may witness an increase in the nominal value of agricultural output as a result of general price inflation. This result is consistent with the findings of the study by Ketema [30] applied in Ethiopia. In contrast, previous studies in developing countries such as Nigeria found that inflation negatively and significantly affects agricultural output due to rising agricultural input costs and the erosion of farmers' purchasing power [31]. These disparities illustrate the influence of local market dynamics; nominal inflation may raise the nominal value of agricultural output in Iraq, while the real inflation effect on production and financing costs is more pronounced in those countries. From here, the importance of adopting monetary policies aimed at price stability and enhancing an investment environment that supports real agricultural production and reduces the negative impact of inflation arises.

5.5. Model Validity Check and Diagnostics

Continuing the analysis of results and interpretation of coefficients in the Autoregressive Distributed Lag (ARDL) model, a series of diagnostic tests was conducted to verify the accuracy of the statistical model specifications and to identify potential issues that could affect the reliability and accuracy of the estimates. Among these tests are:

5.5.1. Breusch-Godfrey Test

The Breusch-Godfrey (BG) test is used as one of the standard tools to detect the presence of first-order or higher autocorrelation, and it is considered more flexible compared to the Durbin-Watson test, as it allows for the inclusion of more than one lag order and can be applied even in the presence of lagged dependent variables in the model [32]. **Table 6** illustrates this test.

Table 6. Breusch-Godfrey Serial Correlation LM Test.

F-statistic	**0.376847**	**Prob. F (2,46)**	**0.6881**
Obs*R-squared	0.983352	Prob. Chi-Square (2)	0.6116

The p-values for (F and Chi-Square) exceed the acceptable level of statistical significance (5%), so we accept the null hypothesis, which states that there is no autocorrelation in the model residuals. This result indicates that the random errors in the model are not temporally correlated, which supports the assumptions of the classical regression model and adds further confidence to the results of the estimated model.

5.5.2. Ramsey RESET

The Ramsey test is one of the important diagnostic tests used to evaluate the validity of the standard model specification in applied economic studies, including agricultural economics models. This test is used to detect errors in model specification, such as omitting relevant influential variables, using an inappropriate functional form (such as neglecting squares or logarithms), or the presence of nonlinear interactions among variables [33]. **Table 7** illustrates this test.

Table 7. Ramsey test.

	Value	**Probability**
t-statistic	1.376492	0.1832
F-statistic	1.894731	0.1832

It is clear from **Table 7** that the estimated model is free from the problem of mis-specification, as evidenced by the probability value of 0.1832, which is greater than 5%, indicating the validity of the functional form of the estimated model.

5.5.3. Jarque-Bera Test

The Jarque-Bera test is used to measure the deviation of the residuals from the normal distribution based on both skewness and kurtosis [34]. The histogram of the residuals provides a visual representation that helps in assessing the shape of the distribution and its closeness to the normal distribution [35], as shown in **Figure 1**.

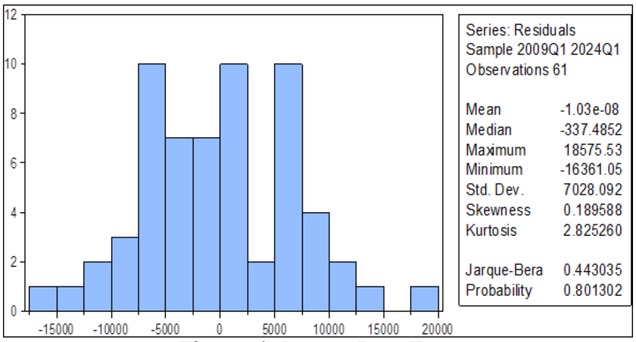

Figure 1. Jarque-Bera Test.

Through **Figure 1,** it is observed that the *p*-value is greater than 0.05, which indicates that the residuals are approximately normally distributed. This suggests that the model used is statistically appropriate and that there are no obvious issues with the distribution. This is a good indicator of the model's quality.

5.5.4. Structural Stability Test

For time series analysis, structural stability tests such as CUSUM and CUSUM of Squares are crucial statistical tools, especially in agricultural economics studies. When policies or climatic conditions alter the relationship between variables, the CUSUM test can help identify possible changes in the model parameters over time. In the meantime, variations in error variance are revealed by the CUSUM of Squares test, which shows shifts in model accuracy. According to Brown et al.[36], these tests are used to evaluate the stability of models over time. The test results are shown in **Figure 2**.

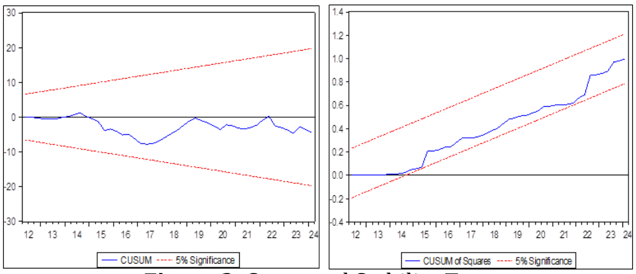

Figure 2. Structural Stability Test.

Figure 2 shows that the CUSUM and CUSUM of squares test curves lie within the upper and lower critical limits at a significance level of 5%, indicating that the cumulative sums are centered around their arithmetic mean, which means that the model estimates for short-term and long-term parameters are consistent and stable.

Based on the validity tests of the model and the diagnostic tests, it is clear that the estimated ARDL model is a good economic and statistical framework for understanding the impact of agricultural public finance tools (government spending and loans) on the contribution of the agricultural sector to the GDP in Iraq. These tests support the validity of the model for statistical inference, analysis, and interpretation.

6. Conclusions

The results of the study showed a statistically significant positive relationship between government agricultural investment spending and the contribution of the agricultural sector to GDP in Iraq during the period from 2008 to 2024. This relationship underscores the critical role of government spending in supporting and developing the agricultural sector, as government investments are the main driver that enhances the capabilities of this sector to modernize agricultural infrastructure, adopt more effective production methods, and expand irrigation and agricultural transport networks. Improving these elements is one of the important factors that contribute to increasing the productivity of the agricultural sector, developing agricultural value chains, and consequently increasing national economic growth. Government agricultural loans have shown a positive and statistically significant effect on agricultural GDP in both the short and long term. However, the effectiveness of these loans may be affected by weak distribution mechanisms and poor oversight, which could limit their true developmental impact.

The results of the Error Correction Model (ECM) indicated that approximately 43.15% of any deviation from the long-term equilibrium relationship is corrected within a quarter of a year, suggesting a moderate speed of adjustment and a relative delay in the agricultural sector's response to financial policies, although this response remains stable over time.

Based on the previous findings, the study recommends the importance of increasing the level of direct government investment in the development of agricultural infrastructure, focusing on projects to improve irrigation networks, build modern agricultural roads, and apply advanced agricultural technologies that contribute to increasing land productivity and enhancing resource consumption efficiency. It emphasizes enhancing scientific research and innovation in the agricultural sector by supporting research centers, universities, and experimental projects aimed at developing sustainable solutions to agricultural problems in Iraq.

The study further recommends reforms in agricultural loan distribution systems, ensuring they are updated and meticulously organized to direct funds and financing towards effective and productive agricultural projects. This includes establishing transparent and advanced mechanisms for monitoring and managing these loans, along with strengthening accountability mechanisms to prevent financial and administrative corruption, which is a major barrier to benefiting from government funding to support and develop the agricultural sector in Iraq. Building strong and transparent institutions ensures the optimal use of government financial resources, which positively reflects on the agricultural sector's contribution to the gross domestic product, thereby contributing to achieving comprehensive and sustainable economic development in Iraq.

Author Contributions

Methodology, S.S.A; formal analysis, F.G.F; data curation, M.K.O; writing—original draft preparation, H.S.H and M.S; writing—review and editing, T.A.S. and M.K.A. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest

The authors declare no conflict of interest.

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