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Understanding the Causes of the Decline in the Iraqi Agricultural Sector's Contribution to the GDP

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Abstract. The agricultural sector is one of the most important economic sectors in Iraq. It is ranked second after the crude oil sector in terms of its contribution to the gross domestic product (GDP). However, its contribution to the GDP declined from 26.93% in 1991 to 10.86% in 2004, 7.23% in 2010, and 4.77% in 2020. This decline can be attributed to many determinants of agricultural production that had a significant impact; therefore, this study aimed to investigate the determinants of agricultural production in Iraq during the period 2004:1- 2020:4 using the Autoregressive Distributed Lag Model (ARDL). The study concluded that there is a short and long-run equilibrium relationship between the GDP and the cultivated area, corruption, inflation, agricultural investment, agricultural production requirements, the availability of water, and employment in agricultural, on the other hand. The results indicated the significant impact of these variables on agricultural GDP in the long run. The main variables contributing to the agricultural GDP are water availability, corruption, and employment in agricultural. The estimates of the short-run parameters would correspond in terms of signs and significance with the results of the long-run estimates, even if the parameters' values varied in different proportions. It indicates that the Iraqi agricultural sector suffers from a lack of optimal use of agricultural resources. Therefore, decision-makers in Iraq must adopt an effective agricultural policy by setting plans for the optimal use of water and paying attention to the human element to be qualified to carry out employment in agricultural and attract investment in the agricultural sector to develop it. It is also necessary to put in place financial and economic policies that reduce the adverse effects of inflationary pressures in the short and long terms, combat rampant corruption in the country, and preserve agricultural lands and reclamation of unsuitable lands.

Keywords: Agricultural GDP, Agricultural Investments, Inflation, Corruption, ARDL.

1. Introduction

The agricultural sector is one of the most critical sectors in the Iraqi economy, as it is ranked second after the oil sector in terms of its contribution to the GDP. It provides raw materials of plant and animal origin for Iraqi industries and provides commodities for export. In addition, the agricultural sector is the primary source of inputs for manufacturing industries. Nevertheless, unfortunately, the agricultural sector has been unable to meet the population's growing needs due to Iraq's wars and unwise policies during the past years.

In the fifties of the last century, Iraq was exporting wheat, barley, and dates to Europe, and the prices of these products appeared daily in global market indicators despite the modest levels of technology and the dominance of the feudal system in Iraq that time. After the sharp decline in agricultural production and the increased demand for foodstuffs, Iraq has become a significant importer of grains and foodstuffs. Despite the strategies that were followed to improve the situation of the agricultural sector, Iraq did not reach the required level. As a result, the contribution of agricultural GDP to the overall GDP continued to be weak, making the Iraqi economy largely dependent on oil revenues to import foodstuffs for local consumption. In addition, it made Iraq a market for exchanging goods from other countries, which burdened the Iraqi economy with large debts due to the massive imports.
The contribution of the Iraqi agricultural sector to the overall GDP was 26.93% in 1991; it declined to 10.86% in 2004, then 7.23% in 2010, and that contribution continued to decline until it reached 4.77% in 2020 (Central Statistical Organization, Iraqi Ministry of Planning). Hence, it is imperative that attention be paid to this sector and that its problems are addressed and developed at a level that balances its importance and role in Iraq's economic and social development.
Despite the availability of agricultural components in Iraq; the agricultural sector is still unable to provide sufficient food to meet the population's needs, which is increasing at rates that exceed the growth rates of agricultural production. Although agriculture plays a significant role in increasing the production of the other economic sectors, agricultural production lags behind the rest of the other sectors. Although the fact that the growth of the agricultural sector is the most crucial input for agricultural development, which requires studying everything related to the advancement of this sector and searching for the most critical determinants of its growth.
Many studies have been conducted that focused on the study of the determinants of agricultural production in the Arab countries and Iraq, such as the study of [1], the study of [2] and the study of [3]. However, what distinguishes this study from those studies is its use of one of the indicators of economic freedom, which is corruption. The study of [4] indicated the impact of corruption on agricultural production in Iraq; in addition to that, it differs from those studies in that it covers the data of recent years.
This study assumes that the impact of the cultivated area, employment in agricultural, agricultural production requirements, water availability, corruption, inflation, and agricultural investment is effect on GDP is significant. This study also assumes the existence of a short and long-run equilibrium relationship between GDP and those variables.
This study investigates the determinants of agricultural production that decrease the contribution of this sector to Iraq's GDP for the period 2004:1 – 2020:4 by using ARDL.The importance of this study lies in identifying those determinants and the contribution of this study to economic growth, which is increasingly interested in studying issues related to economic growth at the local and global levels.
This study will be categorized into five sections. The second section contains a literature review concerning the most important agricultural production determinants in Iraq and the world. The third section describes the standard model and the statistical method used in the study. The fourth section presents an analysis of the results, and finally, the fifth part deals with the most critical conclusions that have been reached.

2. Literature Review
The agricultural sector is exposed to a remarkable decline in its contribution to GDP in many countries, including Iraq. It is due to many determinants in the agricultural sector that had a significant impact on the growth of this sector. Many studies focused on this topic, including [1] study, which investigated the hypothesis that agricultural production in Iraq is low due to a set of determinants that affected it. The studied variables are: capital and labour used in plant and animal production, the area of cultivated land, the amount of grain used in plant production, chemical technology, the number of drawers, the number of harvesters, the number of animals, the number of vaccines, slaughtered poultry, and the amount of feed in both plant and animal production for the period 1985-2016 using the two-stage least squares and multiple linear regression methods.
The study of [3] was concerned with the analysis of the determinants of agricultural production and the impact of their contribution on the growth and development of agricultural production in Iraq for

the period 1985 - 2005. This study used agricultural GDP as the dependent variable and investment in the agricultural sector, cultivated area, employment in agricultural, mechanical and chemical technology, and climatic variables as independent variables. The study concluded that the agricultural sector suffers from a lack of optimal use of available resources. The study of [5] aimed to identify the relationship between economic growth and agriculture by measuring the contribution of agriculture to the economic growth by using Ordinary Least Square (OLS) method. This study concluded that agriculture occupies the second place in economic growth and that the industrial sector has benefits more from, exerts a more significant impact on economic growth, than the agricultural sector. Therefore the agricultural sector deserves priority in economic growth. The study of [6] aimed to identify the main determinants of the growth of the agricultural sector in Iran for the period 1970 - 2007 using multiple regression models. It found the poor performance of the agricultural sector, so it is necessary to reduce the migration of young people to the city by finding outlets for work in the agricultural sector and its development.

The study of [7] aimed to identify the most critical ways to transform the Chinese economy into a new economy through farmers' associations, to bring about changes in the essence of the Chinese agricultural sector. It concluded that these associations are working on effective interdependence with markets and merchants, and they are also working to establish an extension center for technical agriculture. Therefore, the study sees the need for continued government support for Chinese agricultural associations and training farmers to use modern technology. Finally, the study of [8] sought to identify the determinants of agricultural productivity in Kenya using factor productivity, inflation, real exchange rate, labour force, government spending, and climate/precipitation as independent variables, and agricultural productivity as a dependent variable for the period 1980-2013. This study used the Johansen-Granger co-integration method and the Error Correction Model (ECM) to verify the short-run relationship between the studied variables. It found that employment, rainfall, and government spending are the main determinants of agricultural productivity in Kenya in the short run.

3. Data Source and Study Methodology

This study aimed to investigate the impact of cultivated area (AREA), inflation (INF) [which is one of the essential variables that show the extent of stationarity in the economic environment], agricultural production requirements [agricultural tractors and combined harvesters] (REQ), investment in the agricultural sector (INVG), employment in the agricultural sector (WORKERS), water availability (WATAR) and corruption (CORR) on Iraq's Agricultural Gross Domestic Product (GDPA).

The method used is the Autoregressive Distributed Lag Model (ARDL) using quarterly data which spanned the duration 2004:1-2020:4.

The data on agricultural GDP, cultivated area, employment in agricultural, agricultural production requirements (agricultural tractors and combined harvesters), and water availability (surface water, groundwater, and rain) were obtained from the [9]. The data on inflation and agricultural investment was obtained from the [10]. Finally, the corruption data was obtained from [11], where the CPI was used, whose index ranges from 0 (very corrupt) to 10 (very clean) [12].

Table 1. Summary of the study variables.

	GDPA	CORR	AREA	INF	INV	REQ	WATER	WORKERS
Mean	9933.506	1.752941	2211.447	9.935906	411134.2	56798.42	2130.353	1520.771
Median	6454.048	1.760937	2681.652	2.818801	314688.4	79089.69	617.0438	1503.656
Maximum	72750.71	2.225000	3986.097	56.76905	1477204.	93000.68	19719.94	1900.075
Minimum	41847.82	1.287500	35.5000	0.154871	119598.8	5547.087	2176.297	1215.344
Std. Dev.	17339.04	0.248869	1117.451	14.90198	384782.4	34893.50	4383.195	175.8781
Skewness	2.141692	0.179033	-0.529470	1.871372	0.908715	0.870422	3.182448	0.195331
Kurtosis	9.890300	2.234913	2.264220	5.462402	3.480621	1.862810	12.41654	2.501295
Sum	675478.4	119.2000	150378.4	675.6416	27957128	3862293.	144864.0	103412.4
Sum Sq. Dev.	2.01E+10	4.149685	83662696	14878.62	9.92E+12	8.16E+10	1.29E+09	2072518.
Obs	68	68	68	68	68	68	68	68

It is evident from Table 1 that the average GDP was 9933.5 million dollars, the lowest value was 41847.8 million dollars, and the highest value was 72750.7 million dollars. The average value of corruption in Iraq was 1.75, the highest value was 2.2, and the lowest value was 1.28, which indicates the extent of rampant corruption in Iraq since Iraq is considered one of the most corrupt countries. Regarding the cultivated area, its average value was 2211.5 thousand hectares, where the lowest value was 35.5 thousand hectares, and the highest value was 3986 thousand hectares. As for inflation, the lowest value was 0.15, and the highest value was 56.76, with an average of 9.9, which indicates the significant fluctuation in inflation in Iraq. The average value of the agricultural investment was 411134.2 million Iraqi dinars. Its highest value was 1477204 million dinars, and the lowest was 119598.8 million dinars, which means a bit of investment in the agricultural sector. Regarding the farmers' supplements with agricultural production requirements (agricultural tractors and combined harvesters), its average value was 56,798 tractors, its highest was 93,000, and the lowest was 5547. Regarding the water availability (surface water, groundwater, and rain), the average value was 2130 billion / m3, where the lowest was 2176 billion/m3, and the highest was 19720 billion/m3. As for agricultural labour, its average was 1521 workers, where the lowest value was 1215 workers, and the most significant number was 1900 workers, which indicates the lack of employment in the agricultural sector due to migration to the city in search of job opportunities.

3.1. Econometric Model

There are several ways to test the existence of co-integration among the variables (e.g. Engel and Granger; and Johansen and Juselius), which requires that the variables under study be non-stationary in their levels and stationary in the first difference [13], [12] and [14]. The results obtained from previous methods are inaccurate in the case of using small samples, so the use of ARDL has become an appropriate alternative [4]. Its use assists in estimating short and long-run results together at the same time and the resulting estimations of this model are characterized by bias and efficiency, as well as it helps to get rid of the problems of autocorrelation. The ARDL test is appropriate even when the sample size is small. It is worth noting that the ARDL may be used regardless of whether the variables under study are integrated of degree zero; I(0) or integrated of degree one; I(1), provided that the time series of the variables are not integrated of degree two; I(2). The use of the ARDL test among the variables understudy in the framework of the Unrestricted Error Correction Model (UECM) takes the following form between the dependent variable (Y) and the independent variables (X):

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^{p} \alpha_1 \Delta Y_{t-i} + \sum_{i=1}^{n} \delta_i \Delta X_{t-i} + \lambda_1 Y_{t-1} + \lambda_2 X_{t-1} + \varepsilon_t$$

Where: Δ refers to the first differences of the variables, (n and p) are the time of slowing down of the variables, $\lambda_1 \lambda_2$ are the coefficients of the long-term relationship, and δ_i *and* α_1 the coefficients of the short-term relationship, ε_t representing the random error term with arithmetic mean equal to zero and a constant variance.

The first step in the ARDL test is to test for the existence of a long-run relationship between the studied variables. It is conducted by calculating the F-Statistics for the coefficients of the variables with the tabulated and computed F-statistics value [15]. Since the F distribution is a non-standard distribution, it has two critical values. The first value is the minimum value, which assumes that all the variables are static in their level, that is, they are integrated of the zero order, I(0); and the second value is the value of the upper limit and assumes that all the variables are static in their first difference, that is, they are integrated of the first order, I(1). Suppose the value of the calculated F-statistics is greater than the upper bound value of the tabulated F. In that case, the null hypothesis that states that there is no co-integration between the variables is rejected.

The alternative hypothesis states that there is a co-integration between the variables is accepted. However, if the calculated F-statistics is less than the lower bound value of the tabulated F, the alternative hypothesis states that co-integration among the variables is not accepted. Then the null hypothesis is accepted; there is no Co-integration among the variables, and the conclusion is that there is no Co-integration among the variables. However, if the calculated F-statistics lie between the lower and upper bounds, then we are unable to decide whether or not there is a co-integration between the variables. The general formula for the hypotheses of co-integration among the variables in the ARDL is:

$$H_0: \tau_1 = \tau_2 = \tau_3 = \ldots\ldots = \tau_i = 0$$
$$H_1: \tau_1 \neq \tau_2 \neq \tau_3 \neq \ldots\ldots \neq \tau_i \neq 0$$

It means that there is no long-run equilibrium relationship among the variables against the alternative hypothesis that indicates the existence of co-integration among those variables. In the case of co-integration among the variables, the next step is to estimate the long-term equation among the variables under study by the following formula:

$$Y_t = \beta + \sum_{i=1}^{m} \alpha_i Y_{t-i} + \sum_{i=1}^{n} \lambda X_{t-i} + \varepsilon_t$$

Where: λ *and* α is the coefficients of the variables, (n and m) are the appropriate lag periods for those variables, ε is the limit of the random error.

The third step is to estimate the transactions in the short run by building the following error correction model:

$$Y_t = C + \sum_{i=1}^{m} \lambda_i Y_{t-i} + \sum_{i=1}^{n} \varphi X_{t-i} + \phi ECT_{t-1} + \varepsilon_t$$

Where: ECT_{t-1} is the error correction term; ϕ is the speed of correcting the actual values towards the equilibrium values of the dependent variable, which reflects the long-run effects. The value of this coefficient ranges between zero and one.

3.2. Stationary Test

Stationarity is one of the essential topics in the study and analysis of time series, where the relationship between non stationary variables is misleading, and this is called Spurious Regression [16]. Therefore, the stationary test will be conducted before the ARDL test. Many statistical methods are used to test the stationarity of time series, the most important of which is the Unit Root Test, one of the most accurate and widely used methods. The Unit Root Test aims to determine whether or not the variables are stationary and determine each variable's integration rank. If the original time series is stable in its original values, then it is integrated of zero-order; I(0). However, if the series is stationary after the first difference, then the series is integrated from the first order; I(1). If the series is stationary after taking the second differences, then that series is integrated of the second order; I(2). The series is generally integrated with order d if stationary after taking the difference d, I(d). Unit Root Test can be performed in several ways, the most important of which are: and Augmented Dickey-Fuller test (ADF) and Phillips Perron test (P.P). The ADF test is one of the most famous tests used to test the stationarity of time series and determine the degree of its integration. The ADF is based on the following equations:

$$\Delta Y_t = \beta + \alpha Y_{t-1} + \sum_{i=1}^{m} \lambda_i \Delta Y_{t-i} + \varepsilon_t \quad \text{(Intercept)}$$

$$\Delta Y_t = \beta_1 + \beta_2 t + \alpha Y_{t-1} + \sum_{i=1}^{m} \lambda_i \Delta Y_{t-i} + \varepsilon_t \quad \text{(Intercept and Trend)}$$

Where: Δ refers to the first difference of the time series. (Y_t and λ) are parameter of the lagging variable, t is the time direction, and ε is the pure white noise error term.

The Phillips Perron Test (P.P) differs from the ADF test in that it does not contain lagging values for the differences and takes into account the correlation in the first differences of the time series. The hypotheses in the ADF and P.P. tests are as follows:

$$H_0: \gamma = 0 \quad ; \text{VS.} \quad H_1: \gamma < 0$$

If the null hypothesis is rejected, then Y_t is stationary, but if it is not rejected, then Y_t is non-stationary.

3.3. Lag Selection Criteria

This test is conducted to choose the appropriate model for the study. First, the appropriate lags are selected in the ARDL model before the specified model is estimated using the OLS method. Second, the optimum Lag period for the variables is chosen by the Autoregressive Model Unrestricted Vector, using one of the following criteria: Akaike Information Criterion (AIC), Schwarz information Criterion (S.C.), Final Predication Effor (FBE), and Likelihood Ratio Test and Hannan and Quinn (H.Q.). Third, the number of lag period is the number on which most of the above criteria are unanimous so that this number has the lowest value of all criteria .Finally, it is necessary to ensure the quality of the model's performance and to know the validity of its use in estimating the long-term relationship between the variables under study, including the Serial Correlation Test, Autoregressive Conditional Heteroscedasticity (ARCH) and Normality Test.

4. Results and Discussion

Multiple tests for time-series stationarity and co-integration were performed using ARDL model. The coefficients of the long-run model of the study variables (cultivated area, corruption, inflation, agricultural investment, animal production requirements, water availability, and employment in agricultural on agricultural GDP) were estimated using the ARDL model, as well as the estimation of the error correction formula for the ARDL model and the short-run coefficients of the study variables and finally, the structural stability test of the ARDL model coefficients.

4.1. Unit Root Test

The ADF and P.P tests were used to test whether the study variables (cultivated area, corruption, inflation, agricultural investment, agricultural production requirements such as harvesters and agricultural tractors, water availability, employment in agricultural, and domestic agricultural product) are stationary or not. In addition, the degree of Co-integration of those variables was also determined by it. Table 2 shows the ADF and P.P Test results at the level and the first differences in the level, trend and intercept and none at 1%, and 10%.

Table 2. Results of the unit root test (ADF and P.P Tests).

	Augmented Dickey-Fuller (ADF) Test						Phillips-Perron (P.P.) Test						
	Level			1st difference			Level			1st difference			
	Intercept	Trend and Intercept	None	Intercept	Trend and intercept	None	Intercept	Trend and intercept	None	Intercept	Trend and intercept	None	Decision
GDPA	-6.618*** (0.000)	-6.656*** (0.000)	-6.554*** (0.0001)				-9.508*** (0.000)	-9.674*** (0.000)	-9.505*** (0.000)				I(0)
AREA	-0.309 (0.917)	-1.565 (0.795)	-1.1447 (0.137)	-2.852* (0.057)	-3.399*** (0.000)	-2.447*** (0.015)	-0.1.048 (0.731)	-3.243* (0.085)	-0.880 (0.1331)	-4.741*** (0.000)	-4.64*** (0.002)	-4.641*** (0.002)	I(1)
CORR	-0.858 (0.349)	-2.198 (0.482)	-01.407 (0798)	-3.559*** (0.009)	-3.904*** (0.017)	-3.594*** (0.000)	-1522 (0.516)	-1.427 (0.844)	-0.048 (0.633)	-3.62*** (0.007)	-3.894*** (0.017)	-3.657*** (0.000)	I(1)
INV	-2.467 (0.128)	-2.886 (0.174)	-1.491 (0126)	-4.014*** (0.002)	-4.989*** (0.014)	-4.045*** (0.000)	-2.13 (0.234)	-2.251 (0.454)	-1.131 (0.232	-4.062*** (0.002)	-4.042*** (0.012)	-4.088*** (0.000)	I(1)
INF	-6826*** (0.000)	-5.4*** (0.000)	-7.118*** (0000)				-5.058*** (0.000)	-5.026*** (0.000)	-4.851*** (0.000)				I(0)
REQ	-1.173 (0.680)	-2.528 (0.314)	-2.369 (0.995)	-3.162*** (0.027)	-3.240* (0.087)	-1.634* (0.09)	-1.631 (0.461)	-2.689 (0.245)	-1.069 (0.924)	-2.701* (0.078)	-2.72*** (0.007)	-2.755*** (0.006)	I(1)
WATER	-2.454 (0.132)	-2.483 (0335)	-1.686* (0.087)	-3.011*** (0.038)	-3.126*** (0.043)	-3.042*** (0.002)	-2.053 (0.351)	-3.079 (0.119)	-2.738 (0.69)	-5.296*** (0.000)	-5.261*** (0.000)	-5.335*** (0.000)	I(1)
WORKERS	-2.046 (0.731)	-2.226 (0467)	-1.021 (0.273)	-4.619*** (0.000)	-4.606*** (0.002)	-4.667*** (0.000)	-0.723 (0.833)	-1.829 (0.679)	-1.043 (0.364)	-4.307*** (0.001)	-4.31** (0.005)	-4.289 *** (0.000)	I(1)

Note: The figures in parenthesis are p-value,*, *** denote that the corresponding coefficient is significant the 10% and 1%, respectively.

It is clear from Table 3 that the variables (cultivated area, corruption, inflation, agricultural investment, agricultural production requirements, water availability, and employment in agricultural) contain the unit root at the level. It became stationary after taking its first difference; I(1). The agricultural GDP and inflation were stationary at level; I(0).

4.2. Lag selection Criteria

Applying the Co-integration test in the ARDL model among the study variables requires determining the appropriate lag periods for the study variables using S.C., AIC, FBE, H.Q., and L.R. [15], as shown in Table 3.

Table 3. Lag selection Criteria.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-3991.030	NA	1.89e+45	126.9533	127.2255	127.0604
1	-3319.258	1151.609	7.99e+36	107.6590	110.1083	108.6223
2	-3205.352	166.3386	1.80e+36	106.0747	110.7011	107.8943
3	-3160.475	54.13783	4.28e+36	106.6817	113.4853	109.3576
4	-2972.108	179.3972	1.44e+35	102.7336	111.7143	106.2658
5	-1793.917	822.8632*	1.86e+20*	67.36245*	78.52036*	71.75091*

* indicates lag order selected by the criterion

It is clear from Table 3 that the lag for the study variables is five-time lags for all tests.

4.3. Co-integration Test

The ARDL model based on the UECM and the Bound Test proposed by [17] is considered the most appropriate test for co-integration between the study variables, according to the following formula:

$$\Delta GDPA_t = \alpha + \sum_{i=0}^{p} \phi_i \Delta GDPA_{t-i} + \sum_{i=1}^{n} \beta_i \Delta AREA_{t-i} + \sum_{i=0}^{m} \delta_i \Delta INF_{t-i} + \sum_{i=0}^{p} \eta_i \Delta INV_{t-i} + \sum_{i=0}^{q} \vartheta_i \Delta CORR_{t-i} +$$

$$\tau_1 AREA_{t-1} + \tau_2 INF_{t-1} + \tau_3 INV_{t-1} + \sum_{i=0}^{s} \varsigma \Delta WATER_{t-i} + \sum_{i=0}^{c} \eta \Delta WORERS_{t-i} + \sum_{i=0}^{r} \theta \Delta REQ_{t-i}$$

$$+ \tau_4 CORR_{t-1} + \tau_5 REQ_{t-1} + \tau_6 WATER_{t-1} + \tau_7 WORKERS_{t-1} + \varepsilon_t$$

The following hypothesis is tested:

$$H_0 : \tau_1 = \tau_2 = \tau_3 = \tau_4 = \tau_5 = \tau_6 = \tau_7 = 0$$

$$H_1 : \tau_1 \neq \tau_2 \neq \tau_3 \neq \tau_4 \neq \tau_5 \neq \tau_6 \neq \tau_7 \neq 0$$

By applying the above equation, we get the results of the statistical tests for the regression equation shown in Table 4. It found that it indicates that 99% of the changes in the domestic agricultural product in Iraq are due to corruption, cultivated area, inflation, agricultural investment, production requirements of combine harvesters and agricultural tractors, water availability and employment in agricultural.

Table 4. The result of the unrestricted error correction model estimation.

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
GDPA(-1)	0.592427	0.197812	2.994895	0.0067
GDPA(-2)	0.057497	0.234126	0.245583	0.8083
GDPA(-3)	0.047480	0.233895	0.202995	0.8410
GDPA(-4)	0.400551	0.172353	2.324012	0.0298
GDPA(-5)	0.097094	0.062053	1.564697	0.1319
CORR	44881.62	7580.798	5.920435	0.0000
CORR(-1)	24594.90	13694.42	1.795980	0.0862
CORR(-2)	1685.614	14666.65	0.114928	0.9095
CORR(-3)	2412.854	14626.38	0.164966	0.8705
CORR(-4)	73554.86	16700.72	4.404293	0.0002
AREA	33.75992	7.545525	4.474165	0.0002
AREA(-1)	0.157994	2.250298	0.070210	0.9447
AREA(-2)	0.032469	2.252029	0.014418	0.9886

AREA(-3)	0.035769	2.250515	0.015894	0.9875
AREA(-4)	16.52769	3.786122	4.365335	0.0002
INF	1698.905	389.0190	4.367150	0.0002
INF(-1)	-153.9720	111.2334	-1.384225	0.1802
INF(-2)	-4.807758	116.0436	-0.041431	0.9673
INF(-3)	-26.26379	115.8580	-0.226689	0.8228
INF(-4)	-1403.083	295.9905	-4.740298	0.0001
INV	-0.009378	0.004351	-2.155323	0.0423
INV(-1)	1.50E-05	0.006509	0.002311	0.9982
INV(-2)	0.000654	0.006520	0.100367	0.9210
INV(-3)	0.000597	0.006513	0.091598	0.9278
INV(-4)	0.033985	0.010438	3.255848	0.0036
REQ	0.607971	0.107392	5.661233	0.0000
REQ(-1)	0.080147	0.091147	0.879324	0.3887
REQ(-2)	0.007486	0.092820	0.080653	0.9364
REQ(-3)	0.007832	0.092793	0.084401	0.9335
REQ(-4)	0.101738	0.063746	1.595978	0.1248
WATER	3.110767	0.747887	4.159408	0.0004
WATER(-1)	0.107406	0.250477	0.428806	0.6722
WATER(-2)	0.015927	0.251569	0.063310	0.9501
WATER(-3)	0.041285	0.251111	0.164408	0.8709
WATER(-4)	3.925526	0.889935	4.411027	0.0002
WORKES	474.2397	38.30948	12.37917	0.0000
WORKERS(-1)	204.0010	64.57296	3.159233	0.0045
WORKERS(-2)	14.35469	77.83978	0.184413	0.8554
WORKERS(-3)	19.43639	77.68148	0.250206	0.8047
WORKERS(-4)	176.5380	60.90029	2.898804	0.0083
C	-657387.9	132321.9	-4.968097	0.0001

R-squared	0.997116	Mean dependent var	10476.78
Adjusted R-squared	0.991872	S.D. dependent var	17910.84
S.E. of regression	1614.731	Akaike info criterion	17.86122
Sum squared resid	57361844	Schwarz criterion	19.25596
Log-likelihood	-521.6284	Hannan-Quinn criteria.	18.40978
F-statistic	190.1555	Durbin-Watson stat	1.777999
Prob(F-statistic)	0.000000		

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

The statistically estimated model is valid. All study variables are statistically significant (Table 4). The value of R^2 was 99%, which indicates that the corruption, cultivated area, inflation, agricultural investment, agricultural production requirements, water availability, and employment in agricultural, and it significantly shows the behaviour of the domestic agricultural product. Also, the F-test was statistically significant at 1%, which confirms the significance of the estimated model as a whole. To verify the existence of co-integration between the studied variables, the boundary test for co-integration is used, which takes the following formula:

$$\Delta GDPA_t = \alpha + \sum_{i=0}^{p} \phi_i \Delta GDPA_{t-i} + \sum_{i=1}^{n} \beta_i \Delta AREA_{t-i} + \sum_{i=0}^{m} \delta_i \Delta INF_{t-i} + \sum_{i=0}^{p} \eta_i \Delta INV_{t-i} + \sum_{i=0}^{q} \vartheta_i \Delta CORR_{t-i} + \sum_{i=0}^{r} \theta \Delta REQ_{t-i} + \sum_{i=0}^{s} \varsigma \Delta WATER_{t-i} + \sum_{i=0}^{c} \eta \Delta WORERS_{t-i} + \varepsilon_t$$

Table 5 shows that the calculated value of 5.4 is greater than the critical value of the corresponding upper limit of 3.9 at the 1% level of significance. It means accepting the alternative hypothesis, which states the existence of a co-integration among the study variables. It means a long-run equilibrium relationship between agricultural GDP and corruption, cultivated area, inflation, investment in the agricultural sector, agricultural requirements such as tractors and harvesters, water availability, and employment in agricultural. That is, these variables change together in the long-run, and the current values of local agricultural production are affected by their current value and previous values: corruption, cultivated area, inflation, investment in the agricultural sector, agricultural requirements such as tractors and agricultural combines, the amount of water and employment in agricultural.

Table 5. Co-integration results.

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.400860	10%	1.92	2.89
k	7	5%	2.17	3.21
		2.5%	2.43	3.51
		1%	2.73	3.9

4.4. Estimation of Long-Run Model Parameters

After ascertaining the existence of a long-run equilibrium relationship between agricultural GDP and the study variables, the parameters of the ARDL model for the long and short runs and the error correction parameter are estimated based on the number of lags periods specified following the criteria for choosing the optimal deceleration period and for all variables. Table 6 shows the estimates the model's parameters for the long run.

Table 6. Long-run coefficient of ARDL.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CORR	0.5899617	0.1006511	5.861455	0.0000
AREA	0.1892626	0.04198266	4.508114	0.0002
INF	0.3580953	0.04254460	8.416939	0.0000
INV	-0.2680600	0.0632100	-4.240595	0.0003
REQ	0.4651700	0.0424270	10.96411	0.0000
WATER	0.7542898	0.1348650	5.592925	0.0000
WORKERS	0.4826025	0.5684276	8.490132	0.0000
C	-71.82718	8.410582	-8.540097	0.0000

There is statistical significance for all the coefficients of the estimated variables in the long run, as shown in Table 6. A decrease in corruption in Iraq by 1% will lead to a substantial increase in agricultural GDP by 59%. It indicates the significant obstacle that corruption places in the growth of domestic agricultural production and thus on the agricultural sector's contribution to the gross domestic product. Whereas, if the cultivated area increases by 1%, the agricultural production will increase by 19%. It indicates that the expansion of the cultivated areas will positively affect the increase in agricultural production.

The increase in the inflation rate 1% will lead to a decrease in agricultural production in Iraq by 36%, this indicates that high inflation leads to a rise in production costs and thus will be affected the local agricultural production. Also, increasing agricultural investment 1% will lead to an increase in agricultural GDP by 26%.

Increasing the availability of agricultural production requirements such as tractors and agricultural combines 1% will increase agricultural GDP by 47%. It is also clear from Table 6 that an increase in the availability of water for irrigation, whether it is river water, rainwater, or groundwater by 1%, will lead to an increase in agricultural production by 75%. It indicates the importance of adequate water availability to increase agricultural GDP. At the same time, an increase in employment in agricultural 1% will lead to an increase in agricultural GDP by 48%, which confirms that employment in agricultural is one of the essential elements of production in the production process. The above results indicate the significant impact of corruption, cultivated area, inflation, agricultural investment, production requirements of harvesters and agricultural tractors, water, and employment in agricultural on the domestic agricultural product in the long term, and thus on the agricultural sector's contribution to the GDP. The most significant impact among the variables on agricultural GDP is the amount of water, then corruption, and then employment in agricultural.

4.5. Estimation of Short-Run Parameters ARDL model

The Error Correction Model was used to measure the short-term relationship between agricultural GDP and corruption, cultivated area, inflation, agricultural investment, production requirements of harvesters and agricultural tractors, water, and employment in agricultural in Iraq. It takes the following formula, which is characterized by measuring the speed of adjustment to rebalance the dynamic model and the advantage of measuring the short-run relationship among the variables.

$$\Delta GDPA_t = \beta + \sum_{i=1}^{n} \beta_i \alpha AREA_{t-i} + \sum_{i=0}^{q} \vartheta_i \Delta CORR_{t-i} + \sum_{i=0}^{m} \delta_i \Delta INF_{t-i} + \sum_{i=0}^{p} \phi_i \Delta INV_{t-i} + \sum_{i=0}^{s} \eta \Delta REQ_{t-i} + \sum_{i=0}^{v} \eta \Delta WATER_{t-i} + \sum_{i=0}^{s} \eta \Delta WORKER_{t-i} + \psi ECT_{t-i} + \varepsilon_t$$

Table 7. Estimates of the short-run parameters and the error correction model for the ARDL

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDPA(-1))	0.507663	0.103255	4.916612	0.0001
D(GDPA(-2))	0.450166	0.122655	3.670170	0.0013
D(GDPA(-3))	0.497645	0.119076	4.179208	0.0004
D(GDPA(-4))	0.097094	0.038081	2.549689	0.0183
D(CORR)	0.4488162	0.05162393	8.693956	0.0000
D(CORR(-1))	0.7428210	0.1406880	5.279916	0.0000
D(CORR(-2))	0.7596772	0.1274300	5.961525	0.0000
D(CORR(-3))	0.7355486	0.1108218	6.637221	0.0000
D(AREA)	0.3375992	0.04291322	7.867022	0.0000
D(AREA(-1))	0.1659593	0.02335919	7.104670	0.0000
D(AREA(-2))	0.1656346	0.02334620	7.094715	0.0000
D(AREA(-3))	0.1652769	0.02239195	7.381089	0.0000
D(INF)	0.1698905	0.02386025	7.120230	0.0000
D(INF(-1))	-0.1424539	0.02040255	-6.982162	0.0000
D(INF(-2))	-0.1429347	0.0193349	-7.355072	0.0000
D(INF(-3))	-0.1403083	0.01885828	-7.440142	0.0000
D(INV)	0.937800	0.300700	3.118345	0.0050
D(INV(-1))	0.392700	0.551800	6.148473	0.0000
D(INV(-2))	0.458100	0.545800	6.336178	0.0000
D(INV(-3))	0.398500	0.509500	6.669618	0.0000
D(REQ)	0.607971	0.073614	8.258908	0.0000
D(REQ(-1))	0.102084	0.053408	1.911387	0.0691
D(REQ(-2))	0.109570	0.051524	2.126571	0.0449
D(REQ(-3))	0.101738	0.044754	2.273269	0.0331
D(WATER)	0.3110767	0.0380752	8.170057	0.0000
D(WATER(-1))	0.3900168	0.0476353	8.187565	0.0000
D(WATER(-2))	0.3884241	0.0486367	7.986233	0.0000
D(WATER(-3))	0.3925526	0.0491504	7.986758	0.0000
D(WORKES)	0.4742397	0.02165648	21.89828	0.0000
D(WORKES(-1))	0.1714563	0.3474254	4.935053	0.0001
D(WORKES(-2))	0.1571016	0.04095229	3.836210	0.0009
D(WORKES(-3))	0.1765380	0.03956644	4.461811	0.0002
CointEq(-1)*	-0.915236	0.112417	8.141455	0.0000
R-squared	0.989848	Mean dependent var		-706.7472
Adjusted R-squared	0.979019	S.D. dependent var		9546.321
S.E. of regression	1382.773	Akaike info criterion		17.60725
Sum squared resid	57361844	Schwarz criterion		18.72985
Log-likelihood	-521.6284	Hannan-Quinn criter.		18.04877
Durbin-Watson stat	1.777999			

* p-value incompatible with t-Bounds distribution.

Table 7 presents that the coefficient was statistically significant, with the expected negative sign. It confirms the existence of a joint integration among corruption, cultivated area, inflation, agricultural investment, agricultural production requirements, water, and employment in agricultural on the domestic agricultural product in Iraq in the short term. The estimated value of the coefficient is -0.92, which means that 92% of the imbalance in agricultural GDP in the previous year was corrected in the current year. Table 6 also shows the presence of a negative effect of the change in inflation on the domestic agricultural product in Iraq in the short run, in addition to a positive effect of corruption, cultivated area, agricultural investment, agricultural production requirements, water availability and employment in agricultural on agricultural GDP in the short term. The estimates of the short-term parameters correspond, in terms of signs and significance, with the results of the long-run estimates, even if the parameters' values varied in different proportions.

4.6. Diagnostic Test

After estimating the model's parameters for the long and short runs and ensuring the estimated model's quality before its approval, diagnostic tests were conducted. These tests were conducted to ensure the quality of the model used in the analysis and that it was free from the Serial correlation test and the Heteroscedasticity test. Tables 8 and 9 show the results of those diagnostic tests for ARDL parameters.

Table 8. Breusch-Godfrey Serial Correlation L.M. Test.

F-statistic	0.533363	Prob. F(1,21)	0.47330.4733
Obs*R-squared	1.560455	Prob. Chi-Square(1)	0.2110.2116

Table 9. Heteroskedasticity Test: Breusch-Pagan Godfrey.

	F-statistic		**1.077498**	**Prob. F(40,22)**	**0.4365**
	Obs*R-squared		41.70965	Prob. Chi-Square(40)	0.2282
Scaled explained S.S .	8.027264	Prob. Chi-Square(40)	8.027264	Prob.Ch (40)	1.0000

Table 8 indicates that the model is free from the serial correlation problem. The ARCH statistics also indicate that the null hypothesis that states the homogeneity of the homoscedasticity in the estimated model, as in Table 9, is not rejected. The Jarque_Bera (J.B.) statistic also indicates that the null hypothesis of normality of the error terms is not rejected, as in Figure 1.

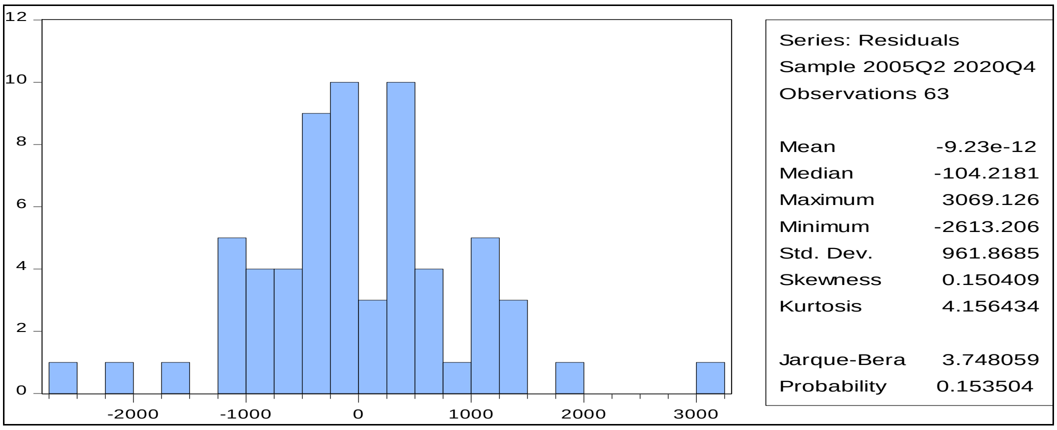

Figure 1. Normal distribution of residuals of the estimated model.

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4.7. Structural Stability Test of UECM-ARDL Parameters

After estimating the error-correction formula of the ARDL model, the next step is to test the structural stability of the short- and long-run parameters based on the Cumulative Sum of Recursive Residual (CUSUM). According to this test, the structural stability of the estimated coefficients in the correct-error format of the ARDL model is ascertained when the graph of the CUSUM statistics is confined within the critical graphs at the level of significance of 5%. These coefficients are not stable in the case of the exit of the critical graphs at the same level of significance. The CUSUM test for this model falls within the critical limits at the 5% significance level, (Figure 1). It indicates that stable in estimating the model between the long- and short-run results; the estimated coefficients of the Unconstrained Error Correction Model (UESM) are structurally stable during the study period.

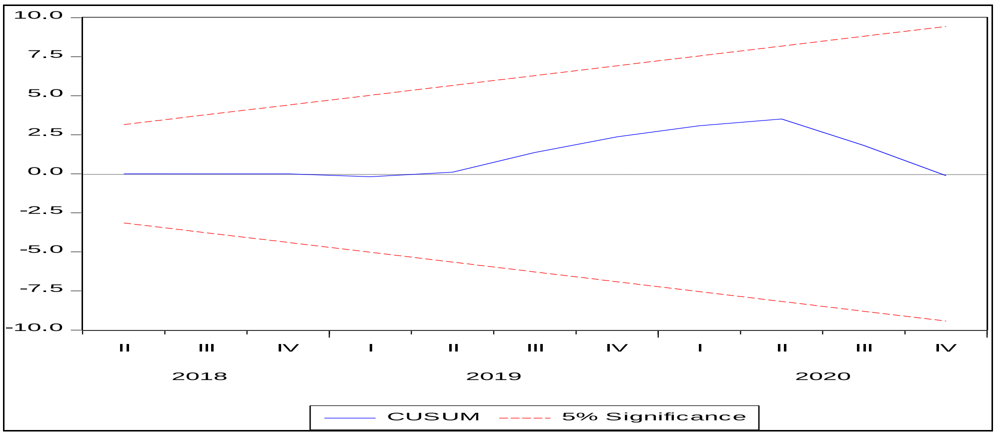

Figure 2. Cumulative sum of residuals returned to test the stability of ARDL parameters.

5. Conclusion

The agricultural sector is considered one of the most critical sectors in the Iraqi economy, as it is ranked second after the oil sector in terms of its contribution to the gross domestic product. However, this contribution began to decline after the Iraqi agricultural sector's contribution to the GDP was 26.93% in 1991, it became 10.86% in 2004, then 7.23% in 2010, and this contribution continued to decline until it reached 4.77% in 2020. This study aimed to examine the determinants of agricultural production, which led to a decrease in the agricultural sector's contribution to the gross domestic product in Iraq for the period 2004:1 – 2020:4 by using ARDL model. Hence, the importance of this study lies in identifying those determinants and the contribution of this study to the field of economic growth, in which interest is increasing in studying issues related to it at the local and global levels. The study concluded that there is a short and long-run equilibrium relationship between agricultural GDP on the one hand and corruption, cultivated area, inflation, investment in the agricultural sector, agricultural requirements such as tractors and combine harvesters, and water availability and employment in agricultural on the other hand.

The study also found the impact of corruption, cultivated area, inflation, agricultural investment, production requirements of harvesters and agricultural tractors, water availability , and employment in agricultural on the domestic agricultural product in the long term, and thus on the agricultural sector's contribution to the GDP. The most significant impact on the domestic agricultural product was the water availability, corruption, then employment in agricultural, as the increase in water availability for irrigation, whether it was river water, rain, or groundwater 1%, would lead to an increase in agricultural production by 75%. A 1% decrease in corruption will increase agricultural GDP by 59%. It indicates the significant obstacle that corruption places in the growth of local agricultural production. An increase in employment in agricultural 1% will lead to an increase in agricultural GDP by 48% in the long run. It confirms that farm labour is one of the essential production elements in the production process. The study concluded that 92% of the imbalance in agricultural GDP in the previous year was corrected in the current year. In addition, the estimates of the short-run parameters correspond in terms of signs and significance with the results of the long-run estimates, even though the parameters' values varied in different proportions.

The Iraqi agricultural sector suffers from a lack of optimal use of the available agricultural resources. Therefore, decision-makers in Iraq must adopt an effective agricultural policy by setting plans for the optimal use of water and adopting modern irrigation methods to confront the problem of water scarcity that Iraq suffers from, and paying attention to the human element to be qualified to carry out employment in agricultural. Measures must be taken to reduce migration from the countryside to the city. It is necessary to attract investment in the agricultural sector to develop it and put in place financial and economic policies that reduce the adverse effects of inflationary pressures and achieve low and stable inflation rates in the short and long terms. Necessary measures must be taken to combat rampant corruption in the country, preserve agricultural lands, reclaim unsuitable lands, and provide agricultural requirements such as tractors and agricultural machines.

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