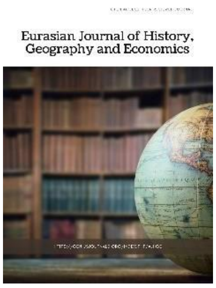

Effect of Oil Prices Fluctuations on Agricultural Gross Domestic Product in Iraq: Autoregressive Distributed Lag (ARDL) Approach

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ABSTRACT

The research dealt with the analysis of the relations between the GDP of the agricultural sector in Iraq, oil prices, the exchange rate and the GDP both on the short term and long term. The research adopted data analysis for the period from 1980-2019 using the ARDL model. the results indicate the existence of long-term relationships between oil prices and the prices of each agricultural commodity at a significance level of 5%. Also, oil prices have a negative consequence on agricultural production in Iraq, and the Iraqi economy is a rentier economy that depends mainly on oil as a source of income and budget financing.

Keywords: Oil Price, Exchange Rate, AGDP, Bounds Test Co-integration, ARDL

1 Introduction

The Iraqi economy depends largely on oil to secure the revenues needed to finance the public budget which has resulted in neglecting other economic sectors, ahead of which is the agricultural sector. The study of the effects of changing oil prices on the gross agrarian product gained special importance after the shear drop in oil prices and the most recent Corona pandemic. These two events led to noticeable negative impact on the global economy in general, and the Iraqi economy in particular, as there is practically no alternative to oil for the Iraqi economy.

The area of Iraq includes four regions according to their topographic division, and they could be arranged in descending order according to their percentage with respect to the total area of Iraq, which amounts to 588 million acre, as follows: 39.2% desert land, 30.2% alluvial plains (including swamps and lakes), 21% highlands, and 9.6% is the undulating plateau in the north between Tigris and Euphrates. The proportion of arable land is 27% of the area of Iraq, or a total of 192 million acres. As for the actually utilized area, it does not exceed 64 million acres, amounting to a third of the arable area only[1].

The agricultural sector has a set of front and back interconnections that make it within a series of sectors that make up the Iraqi economy. The political and economic changes that Iraq has been through have affected this sector as well. This is reflected in the effectiveness of this sector's contribution to the Iraqi economy, which seemed to be low and continuously decreasing. This is apparent from the percentage of GDP or the ratio of total capital formation and the failure of the agricultural sector's production to satisfy Iraq's needs of basic agricultural crops.

Agriculture in Iraq is not only important for providing food to the population, it is actually a basis for many other aspects of life such as health, culture and affluence of Iraqi people. According to [Al-Ansari2021], after oil production, agriculture

[1] See: Iraqi Ministry of Planning, Central Bureau of Statistics, brochure for the development of agricultural statistical indicators for the period 2002-2010.

is the second biggest contributing factor to the GDP and about 20% of the Iraqi population is employed in agriculture. However, the role of this important sector in the Iraqi economy has dropped largely from about 9% in 2002 to about 3.6 in 2009. Furthermore, reclaiming and farming waste lands helps preventing sand storms and stopping desertification, which have a huge positive impact on livelihood. There must be coordinated and interdependent efforts to better development policies and investment plans to make it possible for the agriculture sector to regain an essential role in Iraq's economy.

In prosperous times, the agricultural sector in Iraq aims to satisfy the local needs. This was visible during the Corona pandemic. The pandemic witnessed a decline in agricultural imports which gave a chance for growth in the sector. Iraq is an agricultural country and agriculture must take its role in the creation of the gross domestic product.

Given the Iraqi economy's dependence on oil to secure agricultural commodities, monitoring the impact of oil prices on the agricultural sector is of particular importance in Iraq. The opening of markets and the freedom to import from all over the world after the year 2003 made Iraq an importer of all agricultural commodities. That also led to the deterioration of local agricultural production, which had adversely impacted the process of agricultural development. We observe from Fig. 1 that the GDP of Iraq depends mainly on oil, and from Fig. 2 that the production of the agricultural sector flourishes in periods of low oil prices reflecting more interest in the agricultural sector. Hence, this study comes to address the nature of this relationship to make the agricultural sector more effective and influential on the Iraqi economic growth.

It is clear from the figures that for the period from 1980 to 1990 that the agricultural sector was developing, and then its growth was running parallel to the fluctuations of oil prices. After the economic sanctions on Iraq in 1990 its financial and trade transactions became restricted to oil exports in exchange for food and medicine. During this period, there was growing interest in the agricultural sector to meet local food needs. Markets from all over the world were reopened for Iraq after 2003, which made it an importer of all agricultural commodities. This led to the deterioration of local agricultural production, which has negatively affected the agricultural development process. Hence, this study comes to address the nature of this relationship to make the agricultural sector more effective and influential on Iraq's economic growth.

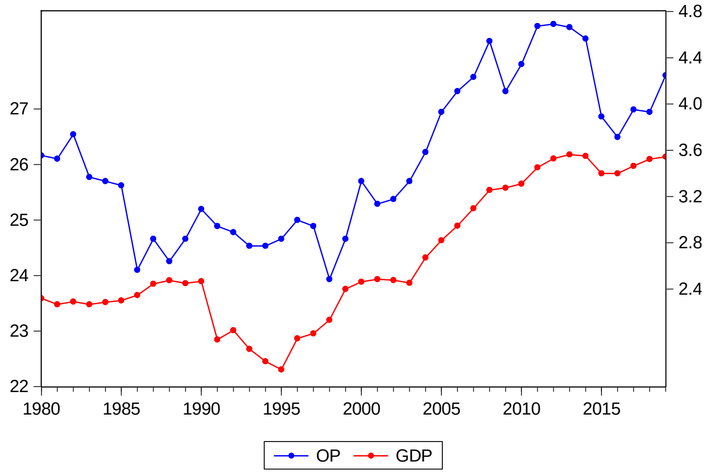

Fig. 1 GDP and Iraq and oil price (OP) fluctuations over the years 1980 to 2019.

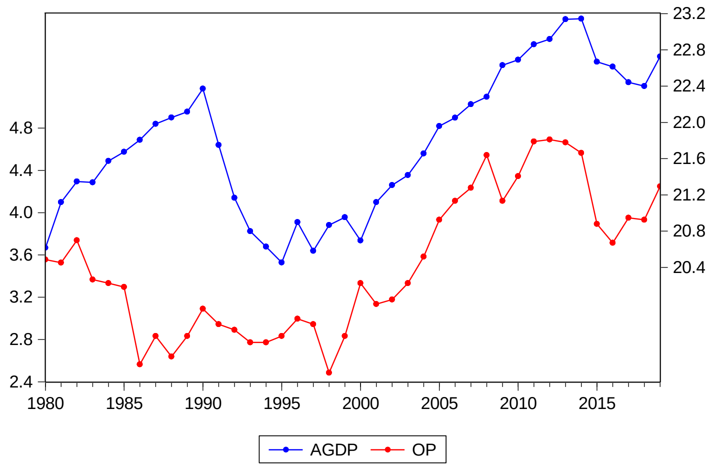

Fig. 2 Agricultural GDP (AGDP) in Iraq and oil price (OP) fluctuations over the years 1980 to 2019.

2 Previous Studies

Studies have addressed with the aftermaths of oil price fluctuations as it represents the drive behind many economic activities, and these fluctuations had always represented a major research problem.

Nazlioglu and Oitas (2012) examine the relationship between oil prices and agricultural commodity prices on a monthly basis around the world using a cointegration and causation approach. The obtained experimental results reflected a strong relationship between them. He pointed out that any policy aimed at stabilizing prices must take that into consideration. It turns out that fluctuations in agricultural commodity prices reflect the relative strength of the US dollar. In addition, the study reflects the importance of synergistic planning for the energy and agriculture sectors.

Zhang and Qu (2015) studied the impact of world oil prices on agricultural commodities in China. The study measured the effect of a group of important agricultural commodities, including wheat and corn in addition to soybeans, beans, strategic commodities, cotton and natural rubber. The results showed that the instability of oil prices has the effect of a combination of smooth and sudden changes, and that oil price shocks have different effects on agricultural commodity prices. However, oil price shocks have been unbalanced for most agricultural commodities, and only the price of natural rubber is affected by higher oil prices.

Apergis and others (2014) examined the effect a sudden expansion in the oil sector has on the added value of agriculture commodity over the period from 1970 to 2011. Co-integration panel tests were used to infer the long-term association between oil returns and agricultural added value. The results showed a long-term negative relationship between oil returns and the added value of agriculture commodities in the studied countries. The results indicate a long-term imbalance of the agricultural sector in response to an oil price shock. Countries with a net loss in the trading sector are therefore in need of direct policy interventions.

Oyelami (2018) takes a look at oil price fluctuations on Nigerian GDP and price levels as well as the exchange rate. The results of the linear ARDL model show that higher oil price will lower the overall price level in Nigeria because the country is a net exporter of oil and the oil revenues are largely used to build needed foreign reserves. Defend the local currency. On the other hand, ARDL nonlinear results (NARDL) show that positive movement in oil prices has a greater impact on production in Nigeria than negative movement in oil prices.

The study of Ayhan and Merv (2015) confirms that international oil prices have a strong impact on agricultural commodity prices. It also indicates that investors should anticipate agricultural commodity prices by monitoring oil price fluctuations.

The agricultural sector in Iraq is very important, however, it has been greatly affected by decades of neglect due to successive wars and economic sanctions leading to many unfavorable social, economic and political factors. Currently, agricultural GDP contributes weakly to Iraq's GDP due to its dependence on oil leading to the trend of importing agricultural commodity and food items ready for domestic consumption instead of producing them. In this work we study the impact of oil price fluctuations on the agricultural sector to highlight the need to pay attention to the agricultural sector in Iraq and to free the Iraqi economy from dependence on one sector, namely, the oil sector.

3 Data and Methodology

The impact of oil price fluctuations on the performance of the agricultural sector in Iraq has been studied. The main economic variables that make up the sample of this study are: GDP, exchange rate, oil price, and agricultural GDP. Annual data for the period from 1980 to 2019 were used for all variables, whereby:

Ln OIL is the oil price,
Ln AGDP is the agriculture sector GDP,
Ln GDP is the Gross Domestic Production, and
Ln EX is the exchange rate.

All the data used where extracted from the United Nations Statistics Division.

3.1 Empirical Methodology

The ARDL model is used to determine the impact of oil prices, the exchange rate, and GDP shocks on agricultural gross domestic product (AGDP) in the long and short term. To achieve this, the target equation will be estimated using AGDP as the dependent variable. To avoid false regression estimates, the time-series properties of the variables will be tested using stability tests to determine the constant level of the variables. If the string variables are constant, their level will be integral I (0), while the other variables are only constant after the first difference will be integral I (1). This procedure has several advantages over other econometric models because it allows the analysis of relationships between variables regardless of the order of regression integration.

3.2 Stationary Test

Generating time series data requires that the non-constant property of each variable be defined. Testing of the null hypothesis (the series is unstable) against the variable state being without a unit root will be done using the ADF and PP test. We must test each chain at all confidence levels and at the first divergence.

All variants are included in the following equation (Greene 2012):

$$\Delta\, y_t = \beta_1 + \beta_2 t + \delta y_{t-1} + \sum_{i-1}^{n} ai\, \Delta\, y_{t=i} + \mu_t$$

This model is described by the ADF test where (μ_t) becomes irrelevant to the desired properties (white noise) of the (OLS) hypothesis, i.e., $\Delta y_{(t-1)} = y_{(t-1)} - y_{(t-2)}$ and $\Delta y_{(t-2)} = y_{(t-2)} - y_{(t-3)}$, etc.. This (n) represents a number of error delay time term period and is determined experimentally. To make the error in (μ_t) not self-correlated (not sequentially correlated), we get the white noise residue. The null hypothesis (H_0: $\delta = 0$) or the existence of the unit root is tested by comparing the tau (τ) statistic estimated for the parameter (τ) with the Dickey - Fuller tabular value developed by (Mackinnon 1991). If the estimated absolute value for (τ) statistic is greater than the absolute value of (DF) then it is statistically significant, meaning that the time series is stable. And, if it is less than the tabulated value, that is, the series is unstable.

The PP test (Kozhan 2010) uses statistical nonparametric methods to treat the autocorrelation of the boundary slowing down. The PP test and the ADF test have the same asymptotic distribution, the same critical values for (τ), and the same statistical significance levels. Table 1 shows the unit test results which indicate that the variables become stationary at the first difference Therefore, the series is stable of order one, I(1).

Table 1: Unit Root Test Results

Variable	The ADF Test		The PP Test	
	Level	First Difference	Level	First Difference
OP	-1.235150	-4.923556*	-1.547254	-5.005336*
EX	-2.477551	-2.014730**	-1.459769	-3.480064**
GDP	0.039339	-5.222920*	-0.261577	-5.322674*
AGDP	-1.235150	-4.923556*	-1.547254	-5.005336*

Note: 1. Tabular values follow p-values from one side by McKinnon (1996). 2. * and ** denote statistical significance levels of 1% and 5%, respectively.

3.2 Johansen Cointegration Test

Co-integration is used to test the long-term relationships between variables (Johansen 1988 and 1991, Johansen and Juselius 1990). This test is preferred when the number of variables under study exceeds two because more than one vector of co-integration is possible. If each internal variable has an equation, then it can be treated as a function of the other internal variables and any other (external) ones. The VAR model takes the following mathematical form (Brooks, Chris2008):

$$y_t = B_1 y_{t-1} + \cdots + B\rho y_{t-\rho} + Bx_t + u_t$$

The Johansen method of joint integration tests the null (H_0) and alternative (H_1) hypotheses. The first one indicates no co-integration, while the other reflects a common complement between the variables. This is done through the use of the Trace test (denoted λ_{trace}) and the Eigenvalue test (denoted λ_{max}), both confirming the existence of one cointegration equation at the 5% significance level. Table 2 shows the results of the Johanssen co-integration test which confirms the rejection of the null hypothesis ($H_0\!: r = 0$,no co-integration vector) and the acceptance and alternative hypothesis ($H_a\!: r = 0$) , with one-variable integration vector among the variables L_{agdp}, L_{gdp}, L_{op}, L_{ex}. In the long run the variables are balanced.

3.3 The Bound Test Approach to Cointegration

The ARDL model involves testing for co-integration relationship between the variables of the model, regardless of the degree of integration of these variables according to the Bound Test approach. Determining lower bounds and upper bounds is done through two complementary tests: F (F-statistic) and W (Wald-statistic) tests; in which the null hypothesis (H_0) is tested against the alternative hypothesis (H_a), indicating no long-term equilibrium if the first one is established, versus long-term equilibrium if the alternative is confirmed otherwise. As the calculated value (F-statistic) and Wald-statistic are compared with the tabular values presented by Psaran et.al (2001). If the calculated F and W statistic is greater than the upper bound, we reject the null hypothesis (there is no joint integration relationship) highlighting the existence of joint integration; and, if it is less than the minimum, the null hypothesis is accepted by the non-existence of the polymorphic integration. Finally, the result is inconclusive when the calculated values are greater than the lower bound and less than the upper bound.

Table 2: Result Johansen Cointegration Test

Trace Test				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.589707	64.88709	54.07904	0.0041
At most 1	0.320424	31.92436	35.19275	0.1080
Maximum Eigenvalue Test20				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.589707	32.96273	28.58808	0.0129
At most 1	0.320424	14.29258	22.29962	0.4356

The results of the co-integration using the bound test method shows in Table (3). The results for the studied sample and the degrees of freedom at the 95% significance level indicate that the value of the F-statistic and the test (Wald's statistic) was greater than the upper limits of the tabular values This is evidence of the existence of a co-integration of the estimated model and this agrees with the results of the Johansen test. The null hypothesis can be rejected and the alternative hypothesis accepted.

Tabel 3: Bound Test Results for Cointegration

F-Statistic: 5.0351			
95%		90%	
Lower Bound	Upper Bound	Lower Bound	Upper Bound
2.6357	3.9595	2.1301	3.2855
Wald-Statistic: 20.1405			
95%		90%	
Lower Bound	Upper Bound	Lower Bound	Upper Bound
10.5430	15.8382	8.5203	13.1420

3.4 Regression of Cointegration According to the ARDL Model

The dependent variable in the ARDL model is expressed in terms of the lag values and the current values of the independent variables (Davidson 1978). The ARDL model generally follows a specific approach, and for this reason it may be possible to address several standard economic problems such as, autocorrelation, and to arrive at the most appropriate interpretable model. It is possible to estimate the ARD model, and takes the following form:

$$\begin{aligned}\Delta \ln \mathrm{AGDP}_t = \ln \alpha_0 &+ \sum_{i=1}^{r} \beta_1 \Delta \ln AGDP_{t-i} \\ &+ \sum_{i=1}^{r} \beta_2 \Delta \ln OP_{t-i} \\ &+ \sum_{i=1}^{r} \beta_3 \Delta \ln GDP_{t-1} \\ &+ \sum_{i=1}^{r} \beta_4 \Delta \ln EX_{t-1} + \lambda_1 \ln AGDP_{t-1} \\ &+ \lambda_2 \ln OP_{t-1} + \lambda_3 \ln GDP_{t-1} \\ &+ \lambda_4 \ln EX_{t-1} + \varepsilon_t\end{aligned}$$

Table (4) shows the results of the covariance regression and the regression functions estimated according to the ARDL model that represents the first term in estimating this model, and using Microfit 5 software that automatically determines the best time lag times according to the (AIC) criterion. Statistical tests of the model showed that the value of the coefficient of determination ($\bar{R}^2$) was high (93%), and that the F-test value was statistically significant (P = 0.000). the statistical value (Durbin h-tatistic) was not significant at the level of 1% and 5% which means there is no autocorrelation in the model. The estimator model does not include normative problems that may negatively affect the accuracy or bias of test results, and this has been shown in diagnostic tests, and the autocorrelation in the model was not shown by Lagrange tests and the autocorrelation test F. So, there is no heterogeneity variance problem in the estimated model. In terms of the Lagrange tests and the F test of correlation, this means that each of the variables is related to a common complementarity relationship (long-term equilibrium) despite its difference and heterogeneity (imbalance) in the short-term relationship.

Table 4: Estimation of cointegration regression by extending the ARDL model

Regressor	Coefficient	T-Ratio	Prob
LAGDP(-1)	0.69454	8.1932	[.000]
LGDP	0.55262	4.5551	[.000]
LOP	-0.069630	-0.88883	[.380]
LEX	-0.036118	-3.4173	[.002]
R-Bar Squared		0.93853	
F- Statistics		F(4,34) 146.0382[.000]	
Durbin's h- statistic		1.0600[.289]	
Diagnostic Tests			
Test Statistics	LM Version		F Version
Serial Correlation	CHSQ (1) = 0.97206[.324]		F(1,33) =0.84354[.365]
Heteroscedasticity	CHSQ (1) = 5.5392[.019]		F(1,33) = 5.4629[.026]

A: Lagrange multiplier test of residual serial correlation

D: Based on the regression of squared residuals on squared fitted values

3.5 Estimation of the Error Correction Model

Determining the short-term relationship between the studied variables will be estimated by estimating the error correction model, which represents the second step of the ARDL model according to the following equation:

$$\Delta y_t = a_0 + \sum_{i=0}^{r} a_{1i}\,\Delta y_{t-1} + \sum_{i=0}^{r} a_{2i}\,\Delta p_{t-i} + \sum_{i=0}^{r} a_{3i}\,\Delta m_{t-i} + \gamma ECT_{t-1} + \varepsilon_t$$

which represents the variables in the first difference formula with adding an error correction term for one time slowdown, symbolized by ECT_{t-1} and with a negative expected value smaller than the correct one ($\lambda < 0$) for its parameter. Since λ represents the velocity of adapting the short-term equilibrium towards the long-term equilibrium, and since the estimated function is a double logarithmic function, the coefficients of this model represent the short-term.

The results in Table (5) of the error correction model with short-term flexibility showed that all the variables have a very strong statistical significance and have the expected sign, except for the negative parameter sign of oil prices, which reflects the inverse relationship in oil prices, output and GDP in the agricultural sector in Iraq. Iraq is a rentier economy country that depends on oil. Whenever oil prices rise, interest in exporting oil increases to finance the budget in exchange for neglecting the rest of the sectors, especially the agricultural sector. Also, most of the agricultural sector's needs of seeds, fertilizers, pesticides, etc. are imported, and thus the negative sign of the exchange rate, which means a 1% increase in the exchange rate, leads to a 3% reduction in agricultural production and a higher GDP, which leads to an increase in the agricultural sector output by 55%.

Table 5: Using the ARDL model to estimate the error correction model and the short-term relationship

Regressor	Coefficient	T-Ratio	Prob
dLGDP	0.55262	4.5551	[.000]
dLOP	-0.069630	-0.88883	[.380]
dLEX	-0.036118	-3.4173	[.002]
ecm(-1)	-0.30546	-3.6034	[.001]
Equation of the ECM error correction model Ecm = LAGDP -.95540*LGDP + .22795*LOP + .11824*LEX			
F-Stat.F(3,26)	F(3,35) 13.2013[.000]		

Note: The dependent variable is dLGDP, and the ARDL model is based on lag periods (1,1,0,0) based on Akaike values.

The results showed that the error term coefficient (ECT (t-1)) expressed as (λ) and its value (-0.30) was negative and significant (p = 0.001). As the value of the error correction factor (λ) means that 30% of the short-run imbalance is caused by any shock or change in the explanatory variables. the error correction rate (λ) indicates that the demand for agricultural imports takes about (3.33) years (0.30 ÷ 1) to return to equilibrium if there is a change in the explanatory variables or a shock in the model. The calculated F-value was (13.2013) which is statistically significant (p = 0.000), and reflects the statistical significance of the model as a whole and its quality.

3.6 ARDL Model for Estimating Long-Term Relationship (Long-Range Elasticity)

Table (6) represents the long-term flexibility of using the double logarithmic formula for the variable data used in the estimation. It is evident from Tables (5 and 6) that the short-term and long-term flexibility of the AGDP variable with respect to the explanatory variables have the same sign, and that the long-term flexibility is greater than the short-term flexibility. This is expected and consistent with economic logic and behavior where there is sufficient time for adjustment, as responding to a long-term change in the explanatory variables increases the rates of impact on the long-term dependent variable.

Tabel 6: Estimating Long-Term Parameters

Regressor	Coefficient	T-Ratio	Prob
LGDP	0.95540	31.6273	[.000]
Lop	-0.22795	-1.0088	[.320]
lex	-0.11824	-3.1788	[.003]

3.7 Stability Test

Structural stability test was performed using the repeated residual sum (CUSUM) and cumulative repeated square (SUSUMSQ) relationships estimated by the ARDL model. Figures (3 and 4) show that the graphs for the two tests lie within the critical limits of the CUSUM and SUSUMSQ tests at the 5% level and vary around zero, proving the stability of the variables of the ARDL model estimated by statistical tests (Bahmani & Youngoing, 2007).

4 Conclusions

The study showed that there is a relationship of balance and co-integration between the GDP of the agricultural sector and each of the oil prices, the domestic product and the exchange rate. Agricultural GDP also takes about (3.3) years to reach the equilibrium value. The reason for the decrease in the GDP by (06%) and (03%) is due to the increase in oil prices and the exchange rate by (1%) respectively, and the increase (1%) in the GDP led to an increase in the agricultural GDP. (55%) in the short term. The existence of an alternative, which is oil, and its high price led to the neglect of the agricultural sector.

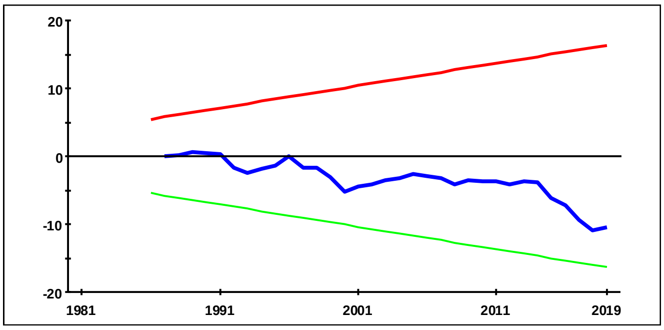

Fig. 3 Cumulative sum of recursive residuals. The straight lines represent critical bounds at 5% significance level.

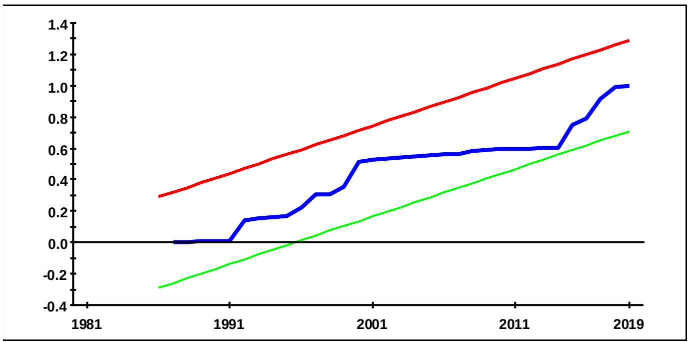

Fig. 4 Cumulative sum of squares of recursive residuals. The straight lines represent critical bounds at 5% significance level.

It also shows the impact of the exchange rate on the agricultural sector because most of the agricultural requirements of seeds, fertilizers, pesticides and agricultural equipment are imported.

The study recommends the need to diversify the sources of income in the local economy by exploiting all available economic resources, including the agricultural sector, to reduce dependence on oil revenues, which is a major source of financing the Iraqi economy. It also indicates the necessity of increasing the real investment allocations for the agricultural sector and harnessing them effectively in increasing and developing the agricultural production capacities, raising the level of agricultural products in proportion to local demand, and benefiting from the comparative advantage that Iraq enjoys cultivating different types of agricultural products.

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