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The Impact of the Agricultural Sector on the Gross Domestic Product in Algeria - An Econometric Study for the Period (2000–2020)

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Abstract:
This study aims to analyze and estimate the impact of the agricultural sector on economic growth in Algeria during the period 2000–2020. To achieve this, a descriptive approach was adopted to analyze the theoretical framework related to the agricultural sector and gross domestic product, alongside a quantitative approach utilizing the Autoregressive Distributed Lag (ARDL) model to measure the relationship between the study variables. The findings reveal a positive and statistically significant correlation between the agricultural sector's value-added and economic growth during the study period. These results highlight the pivotal role of the agricultural sector in diversifying national income sources and fostering economic growth, particularly amidst the structural challenges faced by the Algerian economy and its heavy reliance on the hydrocarbons sector.

Keywords: Agricultural sector, Gross Domestic Product (GDP), Agricultural imports, Economic growth, Agricultural policies, ARDL methodology.
JEL Classification: C51, Q13, O11

Introduction

The agricultural sector in Algeria is one of the fundamental pillars for achieving sustainable economic development. It contributes to increasing gross domestic product (GDP), improving per capita agricultural output, providing employment opportunities, and enhancing living standards in rural areas. The sector enjoys significant natural, human, and material resources, making it a central focus in successive development strategies.

Despite these potentials, studies indicate that the role of the agricultural sector in the national economy remains below the expected level compared to its vast capabilities and the anticipated outcomes of planned development programs. However, 2020 marked a turning point for the sector, as it demonstrated remarkable resilience against the global health crisis caused by the COVID-19 pandemic. The sector even achieved notable progress in production and exports.

For example, Algeria's agricultural exports experienced a qualitative leap, exceeding 100,000 tons in 2020, compared to 70,000 tons the previous year. This upward trend continued in 2021, with 50,000 tons of agricultural products exported in the first quarter alone, according to official data.

1.1 Problem Statement

Based on the introduction, this study seeks to answer the following main research question:

To what extent does the agricultural sector influence Algeria's GDP during the period 2000–2020?

To address this main question, the study relies on the following sub-questions:

- Is it necessary to develop the agricultural sector?
- Does increased agricultural productivity enhance GDP levels?
- Is there a long-term relationship between agricultural production and GDP?

1.2. Study Hypotheses

The study hypotheses are formulated to address the research questions in alignment with theoretical frameworks and the variables under investigation. These hypotheses will later be tested:

- The agricultural sector contributes to bridging the food gap, given Algeria's significant economic potentials.
- Increased agricultural productivity leads to higher GDP levels.
- There is a long-term relationship between agricultural production and GDP.

1.3. Objectives of the Study

The study aims to achieve the following objectives:

- Evaluate the performance of Algeria's agricultural sector to identify its achievements.
- Identify the main challenges hindering the performance of the agricultural sector.
- Highlight Algeria's key opportunities and resources in the agricultural sector to enhance its positive contribution to GDP.

1.4. Literature Review

Numerous studies have highlighted the pivotal role of increased agricultural exports in driving economic growth at the national level:

- **Study by Sayef Bakari & Mohamed Mabrouk (2018):** This study aimed to examine the impact of agricultural exports in Southeast European countries during the period 2006–2016. The production function was used, incorporating variables such as agricultural exports, total exports, total imports, and consumer expenditures, with static panel data. The study concluded that all variables had a positive impact on economic growth, except for total imports and labor.
- **Study by Sayef Bakari (2017):** This research focused on the impact of agricultural exports on economic growth in Tunisia during the period 1988–2014. Using the Vector Error Correction Model (VECM), the study analyzed the relationship between GDP, agricultural exports, investments, non-agricultural exports, and population growth. The findings revealed a positive relationship between GDP and agricultural exports in Tunisia.
- **Study by Mohamed Atta Allah Aleemat (2018):** This study aimed to explore the impact of agricultural exports on Jordan's trade balance during 2007–2012. By employing cointegration tests to estimate the studied relationship, the study found a positive and statistically significant effect of agricultural exports on the trade balance. It concluded that increasing agricultural exports reduces the trade deficit.
- **Study by Abed Bin Abed Al-Abdali (2005):** This study sought to estimate the contribution of exports to economic growth in Islamic countries, members of the Organization of Islamic Cooperation, during the period 1960–2001. Using the Ordinary Least Squares (OLS) method, the study showed that both exports and investment positively impacted economic growth, although the elasticity of each variable was less than one. The inclusion of dummy variables in the model revealed significant differences among groups of Islamic countries (oil-exporting, low-income, and middle-income). For oil-dependent countries, exports were more influential than investment in driving economic growth, whereas for low- and middle-income countries, investment played a more significant role than exports.

1.5. Research Methodology

To address the research problem, the study employs a descriptive-analytical approach as a primary foundation to clarify the research objectives. Additionally, the econometric methodology is applied by estimating and testing cointegration

methods and error correction models, utilizing data processed through the Eviews 12 software. This approach is based on the premise that the agricultural sector contributes to GDP growth, supporting the aim of achieving development beyond the hydrocarbons sector.

2. Discussion of the Research Problem and Theoretical Background

The agricultural sector is one of the vital economic sectors in Algeria due to its significant role in supporting GDP and providing employment opportunities. Its contribution to GDP reached approximately 12.4% in 2020, with a production value exceeding $25 billion, compared to $23 billion in 2019 (Kermadi, 2021). Moreover, the sector provides over 2.5 million jobs, reflecting its pivotal role in the national economy.

In terms of exports, Algeria recorded the export of 50,000 tons of agricultural products in the first quarter of 2021, highlighting significant progress in the sector's trade performance. To promote investment in agriculture, the government announced support of up to 90% of the value of agricultural projects, with a continuous focus on improving productivity, optimizing land use, especially in mountainous areas, and protecting forest resources.

On the food security front, Algeria has made remarkable progress, achieving the top rank in Africa according to the World Food Programme (WFP) classification, placing it in the "blue category," alongside leading global nations. According to the WFP report, Algeria was categorized as food-secure, with less than 2.5% of its population suffering from malnutrition between 2018 and 2020.

The Agricultural Sector's Contribution to GDP

The annual report on the state of Arab food security, published by the Arab Organization for Agricultural Development, indicated that the value of Arab agricultural GDP reached approximately $139.1 billion, representing 5.4% of the total Arab GDP. Algeria contributed 11.5% of this output, underscoring its prominent position in the Arab agricultural sector.

Despite notable progress in food production across the Arab region in recent years, agricultural and fisheries production sectors remain heavily reliant on traditional systems (Al-Ra'id, 2015).

The agricultural sector is one of the cornerstones of Algeria's economy, playing a pivotal role in generating national income, improving living standards, and increasing the average per capita share of national income. National income is one of the key indicators reflecting economic growth and financial stability in the country.

Table 01 illustrates the evolution of the agricultural sector's contribution to Algeria’s GDP over the years, highlighting the changes in the sector and its role in supporting economic growth. This analysis aids in understanding the current trends in the agricultural sector and identifying the factors influencing its growth and sustainability.

Table 01: Contribution of the Agricultural Sector to Algeria's Gross National Product (GNP) during the period (2007–2013) / Unit: Billion DZD

Years	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
GNP	9352.8	11043.7	9968.0	11991.5	14526.6	16115.4	16569.2
Agricultural Output	885.0	982.2	1157.1	1269.8	1478.4	1775.1	2031.6
Share of Agriculture in GNP (%)	9.14	8.89	10.58	10.58	10.17	11.01	12.26

Source: *Office national des statistiques Algérie, Les Tableaux Economiques d’Ensemble 2002 à 2013, N°688, February 2015.*

The table above demonstrates that agricultural output in Algeria achieved significant growth during the period between 2007 and 2013. It increased from 885 billion Algerian dinars in 2007 to 2031.6 billion Algerian dinars in 2013. In parallel, GNP also witnessed notable growth during the same period, rising from 9352.8 billion Algerian dinars in 2007 to 16569.2 billion Algerian dinars in 2013. However, the rate of increase in GNP outpaced that of the agricultural sector, primarily due to the contributions of other sectors, especially hydrocarbons.

Despite the importance of the agricultural sector, its share in GNP remained relatively small. This can be attributed to the limited alignment between the growth in agricultural production and agricultural commodity prices with the overall progress in other sectors.

The following table highlights the per capita share of agricultural output by comparing agricultural output with demographic trends during the period (2007–2013).

Table 02: Evolution of Per Capita Agricultural Output during the period (2007–2013) / Unit: Billion DZD

Years	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**
Agricultural Output	885.0	982.2	1157.1	1269.8	1478.4	1775.1	2031.6
Population (in thousands)	34591	34591	35268	35978	36717	37495	38297
Per Capita Agricultural Output	24.71	28.39	32.80	35.29	40.02	47.34	50.30

Source: *Office national des statistiques Algérie, Statistiques sociales, population et démographie. February 2015.*

The table above indicates that the per capita share of agricultural output in Algeria recorded a significant increase during the period from 2007 to 2013, rising from 24.71 thousand DZD to 50.30 thousand DZD, reflecting a growth rate exceeding 200%. This increase is attributed to the rise in agricultural output during the same period. However, the per capita share of agricultural output in Algeria remains low compared to developed countries.

Despite the vast natural and human resources available in the agricultural sector, coupled with the financial, material, and moral support it has received in recent years, the contribution of the agricultural sector to the gross domestic product (GDP) remains modest. This disparity persists despite the sector's potential and the extensive support provided in recent years.

This weak per capita share of agricultural output can be attributed to:

- **Low agricultural productivity**, due to instability in employment and uncompetitive wages.
- **Limited management of agricultural enterprises**, which restricts growth.
- **Frequent reforms in the sector**, hindering its stability.
- **Rising costs of agricultural production inputs**, particularly fertilizers and farming equipment.

2.2 Contribution of the Agricultural Sector to Job Creation

The agricultural sector also plays a crucial role in providing job opportunities and significantly contributes to reducing unemployment. The following table illustrates this:

Table 03: Contribution of the Agricultural Sector to Job Creation during the period (2008–2014) / Unit: Billion DZD

Years	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**
Total Jobs (in thousands)	885.0	982.2	1157.1	1269.8	1478.4	1775.1	2031.6
Agricultural Sector Jobs (in thousands)	34591	34591	35268	35978	36717	37495	38297
Percentage (%)	24.71	28.39	32.80	35.29	40.02	47.34	50.30

Source: *Office national des statistiques Algérie, Activité, Emploi & Chômage (2008–2014).*

The table above highlights a significant rise in the per capita share of agricultural output in Algeria from 2007 to 2013, increasing from 24.71 thousand DZD to 50.30 thousand DZD, achieving a growth rate of over 200%. This improvement reflects the increase in agricultural output during the same period. However, the per capita agricultural output in Algeria remains low compared to developed countries, underscoring the limited overall performance of the sector.

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2.3. The Contribution of Agriculture to Promoting Other Sectors and Developing the National Economy

The agricultural sector plays a pivotal role in strengthening the national economy through its interactive relationships with other sectors, particularly the industrial sector. This significance is reflected in its dual role: providing raw materials to the industrial sector on one hand, and its dependence on various industrial products such as fertilizers and agricultural production inputs on the other. Experience has shown that delays in agricultural development can jeopardize industrialization and overall economic growth across all branches of the national economy. Conversely, the inability of the industrial sector to meet the needs of agriculture poses a barrier to the development of agricultural production and productivity (Habib, year of publication not specified, p. 40).

Furthermore, agriculture's contribution to promoting exports is another vital indicator of its importance in fostering national economic development. Exports, in general, serve as a critical source of foreign currency to cover import costs and finance local development projects.

3. Methodology and Statistical Tools

Autoregressive Distributed Lag Models (ARDL):

The ARDL models, developed by Pesaran, Shin, and Smith (2001), represent one of the most advanced techniques for estimating econometric models related to time series analysis. Also known as the **Bounds Test**, this approach is commonly employed in studies to verify the existence of both long-term and short-term relationships between study variables by considering an adequate number of lag periods to obtain the best set of data.

The choice of this type of model offers several advantages, among which is the flexibility of the Bounds Test for cointegration. This test can be applied regardless of whether the study variables are integrated of order I(0) (stationary at level), I(1) (stationary after first differencing), or a combination of both, provided that no variable is integrated of order I(2).

$$\Delta Y_t = a_0 + \sum_{j=1}^{P1} \beta_j \Delta Y_{t-j} + \sum_{j=0}^{P2} \gamma_j \Delta X1_{t-j} + \sum_{j=0}^{P3} \delta_j \Delta X2_{t-j} + \dots + \pi_1 Y_{t-1} + \pi_2 X1_{t-1} + \pi_3 X2_{t-1} + \dots + \varepsilon_t$$

Here are the symbols written in a format compatible for copying and pasting into Word Office:

- **Δ**: Represents the first difference of the variable values.
- a_0: The constant term.
- β_j, γ_j, δ_j: Represent the short-term dynamics or movement of the model.
- π_1, π_2, π_3: Represent the coefficients of the long-term relationship.
- ε_t: The error term.

Cointegration Testing Using Pesaran's Bounds Approach

The ARDL model tests for the existence of a cointegration relationship between variables using the bounds test, employing the Wald or F. This involves testing the following hypotheses:

- **Null Hypothesis (H_0):** There is no cointegration relationship between the variables ($\pi1=\pi2=\pi3=0$).
- **Alternative Hypothesis (H_1):** There is a cointegration relationship ($\pi1\neq0,\pi2\neq0,\pi3\neq0$)

The presence of a cointegration relationship between the dependent variable and the independent variables is verified using the bounds test through the Wald test (Fisher statistic). In this context, two bounds of critical values were proposed by Pesaran et al.:

- The **lower bound critical value** is used as a reference for variables integrated of order zero I(0).
- The **upper bound critical value** is used as a reference for variables integrated of order one I(1) (Solarin Sakiru Adebola, Wan Sulaiman, Juhari Dahala, 2011, pp. 24–25).

The decision rule for the bounds test is as follows:

- If the calculated F-statistic exceeds the upper bound critical value, the null hypothesis is rejected, and the alternative hypothesis is accepted, indicating a cointegration relationship between the variables.

- Conversely, if the F-statistic falls below the lower bound critical value, the null hypothesis is accepted, indicating no cointegration relationship.
- If the F-statistic lies between the lower and upper bounds, the result is inconclusive, and the integration order of the time series for the study variables must be re-evaluated (Alaaeddin A. Al-Tarawneh, Ghazi I. Al-Assaf, 2014, p. 08).

4. Results Analysis and Discussion

This research aims to study and analyze the equilibrium relationship between agricultural output, represented by the value added of the agricultural sector, and both agricultural exports and imports, as well as the gross domestic product (GDP) in Algeria during the period 2000–2020. The Autoregressive Distributed Lag (ARDL) methodology was employed using the EVIEWS 12 software. The data for the study were obtained from:

Data Sources

The study relies on the following sources for data collection:

- **Arab Agricultural Statistics Yearbook:** Published by the Arab League - Arab Organization for Agricultural Development, volumes 20 to 40.
- **World Bank Data Website:** https://data.albankaldawli.org

This methodology aims to provide accurate and reliable results about the relationship between the studied economic variables, thereby contributing to practical recommendations for supporting the agricultural sector and the national economy.

Study Population

The study population consists of specific time series data covering the period from 2000 to 2020. To achieve the study's objectives, the following criteria must be met:

- The studied time series should represent a macroeconomic indicator variable.
- All necessary data and information related to the studied variable must be available for the entire study period.

Study Variables and Model

To determine the extent of the impact of agricultural production on Algeria's gross domestic product (GDP), the study variables were identified based on economic theory and previous studies, which include:

- **Independent variables:**
  - Value added of agriculture, forestry, and fisheries (VAGR).
  - Agricultural exports (X).
  - Agricultural imports (M).
- **Dependent variable:**
  - Gross Domestic Product (GDP).

Study Model Formulation

The study model can be expressed in the following linear form:

$$\mathbf{GDP= C_0+C_1X+C_2M+C_3VAGR+ U}$$

Where:

- C1,C2,C3 : Coefficients of the estimated model.

- C0: Constant term.
- U: Represents the random error term, resulting from measurement errors or poor specification of the econometric model due to neglecting some external variables that cannot always be measured.

As for the econometric model, it takes the following form:

$$\Delta GDP_t = a_0 + \sum_{j=1}^{P1} \alpha_j \Delta GDP_{t-j} + \sum_{j=0}^{P2} \beta_j X_{t-j} + \sum_{j=0}^{P3} \Upsilon_j \Delta Mf_{t-j} + \sum_{j=0}^{P4} \delta_j \Delta VAGR_{t-j} + \pi_1 GDP_{t-1} + \pi_2 X_{t-1} + \pi_3 M_{t-1} + \pi_4 VAGR_{t-} + \varepsilon_t$$

4.1. Analysis of Time Series Stationarity

Before proceeding with model estimation, it is necessary to conduct a unit root test to determine the stationarity of the time series of the study variables and the level of differencing required to achieve stationarity. This is done using the Augmented Dickey-Fuller (ADF) test. The obtained results are presented in the following table:

Table 04: Results of the Unit Root Test using the ADF Test

	1st Difference		**Level**		
	None	C	T and C	None	C
M	-5.5742***	-5.5059***	-5.5455***	-0.3805	-1.8537
X	-6.2834***	-7.6888***	-7.1850***	2.1378	0.78
Vagr	-2.5157***	-3.1469***	-3.2256***	2.0897	-1.1559
Pib	-3.7616***	-3.9648***	-4.1410***	0.6813	-1.4892

Source: Prepared by the researcher based on EVIEWS 12 outputs.

***)** Indicates acceptance of the alternative hypothesis (H_1), which states that there is no unit root, meaning the series is stationary at significance levels of **10%, 5%, and 1%**.

Based on the statistical analysis results shown in the table, it is evident that the time series for GDP (PIB), agricultural exports (X), agricultural imports (M), and the value added of the agricultural sector (Vagrare non-stationary at their original levels. However, they become stationary when first differences are applied.

Accordingly, these time series are classified as integrated of order one (I(1)). This classification indicates that these variables require first differencing before being used in econometric models to avoid problems associated with non-stationary series, such as spurious regression.

4.2. Model Estimation

After confirming the stationarity of the time series for the study variables at the first difference level (I(1), it becomes possible to apply the cointegration methodology using the Autoregressive Distributed Lag (ARDL) model. However, before estimating the model, determining the optimal number of time lags for each variable is a crucial step to ensure the accuracy and reliability of the results. These lags can be identified using model selection criteria such as the Schwarz Bayesian Criterion (SBC) or the Akaike Information Criterion (AIC), depending on the nature of the data and the objective of the study.

Determining the Number of Lags and Lag Periods

The optimal number of lags for the model will be determined using the Akaike Information Criterion (AIC), which is one of the most commonly used and accurate methods for selecting appropriate lag periods. This method minimizes the value of the AIC to identify the best model fit for the data.

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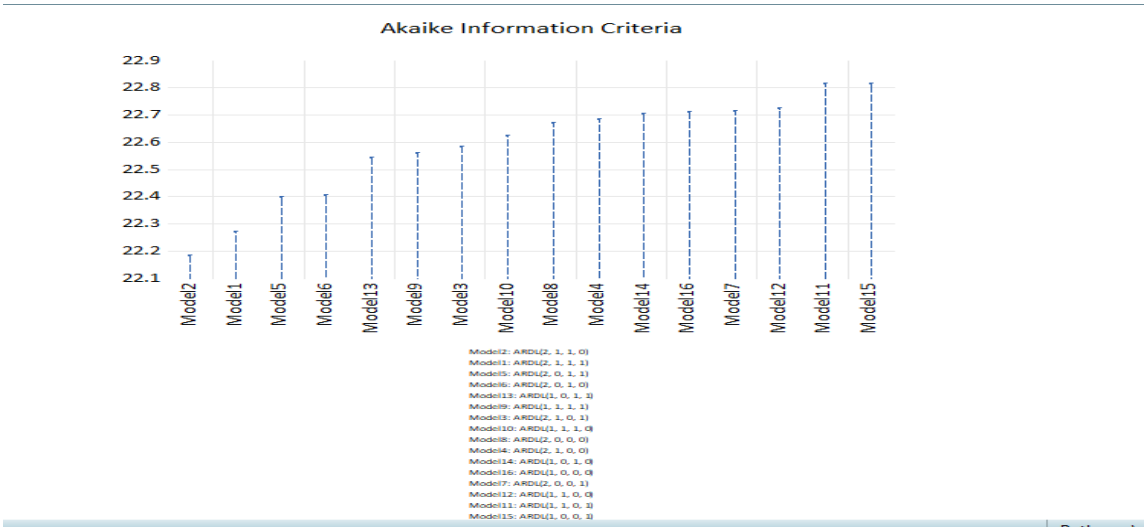
The results obtained are illustrated in the figure below, which highlights the optimal model and the appropriate lag periods for each variable based on this criterion.

Figure 01: Results of Lag Period Testing



Source: Prepared by the researchers based on Eviews 12 software.

By selecting the lowest value of the Akaike Information Criterion (AIC), it was determined that the optimal lag periods for the ARDL model are: **(2,1,1,0)**.

Based on this, the model can be written in its general form as follows:

$$\Delta Pib_t = a_0 + \beta 1 \Delta pibt_{-1} + \beta_2 \Delta\, pib_{t-2} + \beta_3 \Delta\, x_t + \beta_4 \Delta x_{t-1} + \beta_5 \Delta M_t + \beta_6 \Delta M_{t-1} + \beta_7 \Delta vagr_t + \pi_1\, pib_{t-1} + \pi_2 x_{t-1} + \pi_3\, M_{t-1} + \pi_4\, vagr_{t-1} + \varepsilon_t$$

Where:

- ΔPIBt: **:** The change in GDP.
- PIBt−1 وPIBt−2\text{PIB}_{t-2}PIBt−2: Lagged values of GDP.
- Xt وXt−1X_{t-1}Xt−1: Agricultural exports and their lagged values.
- Mt وMt−1M_{t-1}Mt−1: Agricultural imports and their lagged values.
- VAGRt وVAGRt−1\text{VAGR}_{t-1}VAGRt−1: Value added of the agricultural sector and its lagged values.
- α0: The constant term.
- β1,β2,…,β7: Short-term coefficients.
- π1,π2,π3,π4: Long-term cointegration coefficients.
- εt:Random error term.

(A) Cointegration Testing Using the Autoregressive Distributed Lag (ARDL) Methodology

To verify the existence of a long-term equilibrium relationship among the variables within the framework of the Unrestricted Error Correction Model (UECM), Pesaran et al. (2001) proposed a modern methodology known as the Bounds Testing approach.

This methodology compares the calculated statistical values to predetermined critical values at different significance levels (e.g., 1%, 5%, and 10%) to determine whether a long-term relationship exists. The evaluation is based on two boundary values:

1. **Lower Bound:** Assumes that all variables are integrated of order zero I(0).
2. **Upper Bound:** Assumes that all variables are integrated of order one I(1).

- If the calculated F-statistic exceeds the upper bound, this indicates the existence of a long-term relationship.
- If it is below the lower bound, no long-term relationship exists.
- If it lies between the two bounds, the result is inconclusive.

The results of the bounds test are presented in the following table:

Table 05: Results of the Bounds Test

Significance Level	Lower Bound	Upper Bound	F-statistic
10%	2.37	3.2	
5%	2.79	3.67	5.905265
2.5%	3.15	4.08	
1%	3.65	4.66	

Source: Prepared by the researchers based on Eviews 12 outputs.

Based on the results of the cointegration test, the following conclusions can be drawn:

- The calculated F-statistic F=5.905265is higher than the upper bound for all significance levels, including 1%.
- Consequently, we reject the null hypothesis (H_0), which denies the existence of a long-term equilibrium relationship, indicating the presence of a long-term equilibrium relationship between the variables in the model.

A. Estimating the Long-Term Relationship:

To estimate the long-term relationship, after confirming the presence of cointegration among the variables using the **Bounds Test**, the **Error Correction Model (ECM)** methodology is typically employed. The long-term relationship can now be estimated as follows:

Table 06: Results of Long-Term Relationship Estimation for the ARDL Model (2,1,1,0)

Levels Equation	Case 2: Restricted Constant and No Trend
Variable	**Coefficient**
X	50.81885
M	-3.641452
AGR	9.389456
C	2981.196

The long-term equilibrium equation is given by:

EC=PIB−(50.8189·X−3.6415·M+9.3895·AGR+2981.1964)EC = PIB - (50.8189 \cdot X - **EC = PIB - (50.8189*X - 3.6415*M + 9.3895*AGR + 2981.1964)**

Source: Prepared by the researcher based on Eviews 12 outputs.

The above results indicate significant economic analyses reflecting the long-term relationship between agricultural variables and GDP in Algeria. Below is an analysis and explanation of these findings:

1. Long-Term Effects Analysis

- **Effect of Agricultural Exports (X):** The impact of agricultural exports on GDP is positive and significant. This result aligns with economic logic, as Algeria has adopted policies to support agricultural exports, such as encouraging local production and improving the quality of agricultural products to meet international standards. These efforts contribute to increased agricultural exports, which, in turn, stimulate economic growth by improving the trade balance and increasing national income.

- **Effect of Agricultural Imports (M):** The results show that an increase in agricultural imports leads to a decrease in GDP. This reflects the adverse impact of reliance on imported agricultural products, which reduces local value-added. This finding is consistent with economic theory, which highlights how excessive imports can erode domestic production, weakening economic growth.

- **Effect of Value-Added in the Agricultural Sector (VagrVagrVagr):** An increase in value-added in the agricultural sector contributes positively to economic growth. This indicates the importance of the agricultural sector in Algeria's economy, where improving productivity and increasing value-added significantly boost GDP levels.

2. Estimation of the Error Correction Model (ECM) for ARDL

Since the results of the bounds test confirmed the existence of a cointegration relationship among the variables, i.e., a long-term relationship, the short-term relationship can be estimated using the Error Correction Model (ECM) for the ARDL methodology as follows:

Table 07: Short-Term Relationship Estimation Results for the ARDL Model (2,1,1,0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(PIB(-1))	0.572198	0.155464	3.680588	0.0036
D(X)	25.58434	16.67459	1.534331	0.1532
D(M)	-0.886806	1.080435	-0.820786	0.4292
CointEq(-1)*	-1.291911	0.210041	-6.150765	0.0001

Source: Prepared by the researchers based on EVIEWS 10 outputs.

Interpretation of Short-Term Results

- **D(PIB(-1)):** The lagged difference of GDP has a significant positive effect, indicating that past changes in GDP positively influence current GDP in the short term.

- **D(X):** The short-term effect of agricultural exports is positive but not statistically significant at conventional levels.

- **D(M):** The short-term effect of agricultural imports is negative but not statistically significant, indicating minimal short-term influence.

- **CointEq(-1):** The error correction term is negative and highly significant, with a value of −1.291911. This confirms the model's stability and indicates a strong adjustment speed to long-term equilibrium, as approximately 129% of the short-term disequilibrium is corrected in each period.

The results of the Error Correction Model (ECM) estimation indicate that the error correction term coefficient is negative and significant, fulfilling the necessary and sufficient condition. This suggests a dynamic system that naturally adjusts to shocks, requiring approximately **9 months** to achieve equilibrium. This reflects stability in the relationship between the variables and supports the continuation of policies that promote long-term equilibrium.

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Diagnostic Tests

To ensure that this model is correct and reliable for accurate economic analysis and diagnosis, several diagnostic tests are performed:

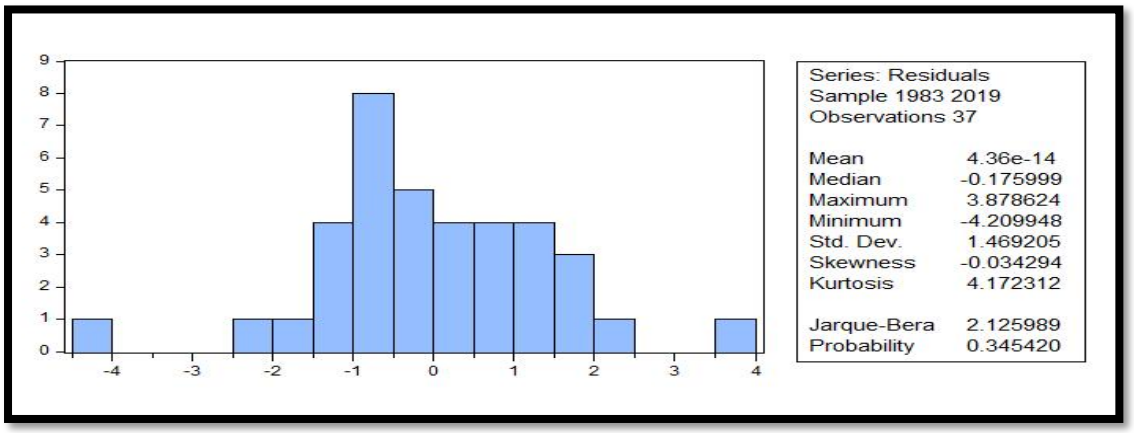
Normality of Errors

The **Jarque-Bera test** is a statistical test used to assess whether the residuals from the estimated model follow a normal distribution. It is based on the skewness and kurtosis of the residuals.

The test involves the following hypotheses:

- **H_0:** Residuals follow a normal distribution.
- **H_1:** Residuals do not follow a normal distribution.

Figure 02: Normality of Error Distribution



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Source: Prepared by the researchers based on Eviews 12 outputs.

The test results, as shown in the figure above, confirm that the residuals of the model follow a normal distribution. The calculated P-value for the Jarque-Bera test is 0.345, which is greater than the 5% significance level. Therefore, we fail to reject the null hypothesis (H0H_0H0), indicating that the basic assumption of the model—normality of residuals—has been satisfied. This enhances the credibility of the estimated statistical model and indicates its suitability for data analysis.

(C) Testing for Autocorrelation in Residuals

The estimated model cannot be considered reliable if its residuals exhibit autocorrelation, as this could negatively impact the accuracy of the estimated parameters and lead to misleading conclusions in significance tests. Therefore, it is essential to ensure that the estimated model is free from this issue using the Breusch-Godfrey Serial Correlation LM Test.

The null hypothesis (H0H_0H0) for this test states that there is no autocorrelation in the residuals.

Table 08: Breusch-Godfrey Serial Correlation LM Test Results

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.845755	Prob. F(2,24)	0.4416
Obs*R-squared	2.436053	Prob. Chi-Square(2)	0.2958

Source: Prepared by the researchers based on Eviews 12 outputs.

The test results, as shown in the table above, confirm that the residuals of the estimated model are free from the problem of autocorrelation. The P-value for the F-statistic is 0.44, which is greater than the 5% significance level. This supports the acceptance of the null hypothesis (H0H_0H0), which states that the residuals do not suffer from autocorrelation. Thus, the estimated model can be relied upon, and its results can be used for analysis and interpretation without concerns about this issue affecting the credibility of the results.

(D) Testing for Homoscedasticity

A key characteristic of a good model is that its residuals exhibit homoscedasticity (constant variance). Violating this assumption leads to biased standard error estimates, resulting in misleading and inaccurate conclusions. Therefore, verifying homoscedasticity is essential to ensure the validity of the estimated model.

In this context, the ARCH (Autoregressive Conditional Heteroskedasticity) test was employed to verify the presence of heteroscedasticity. This test helps detect the influence of previous residuals on the variance of current errors.

Table 09: ARCH Test for Residual Homoscedasticity

Heteroskedasticity Test: ARCH			
F-statistic	0.002290	Prob. F(1,34)	0.9621
Obs*R-squared	0.002424	Prob. Chi-Square(1)	0.9607

Source: Prepared by the researchers based on Eviews 10 outputs.

As shown in the table above, the P-values for both the F-statistic and the Chi-square statistic are greater than the 5% significance level. This clearly indicates that the residuals of the model exhibit homoscedasticity (constant variance). Therefore, the estimated model results can be relied upon without concerns about the impact of heteroscedasticity on the validity of the conclusions.

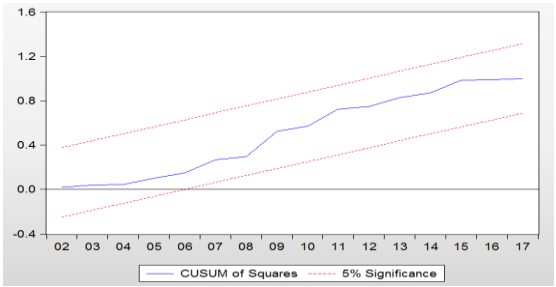
Model Stability Test

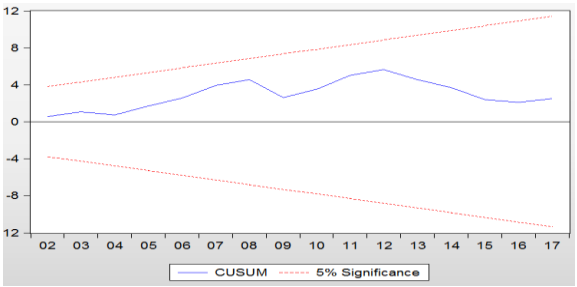
A structural stability test was conducted for the estimated ARDL model for both the short-term and long-term relationships using the following tools:

1. **Cumulative Sum of Residuals (CUSUM) Test:**
   This test aims to verify the stability of the model coefficients over time and detect any structural changes that might affect the accuracy of the results.
2. **Cumulative Sum of Squares of Residuals (CUSUMQ) Test:**
   This test is used to evaluate the stability of variance in the model residuals, reflecting the consistency of standard errors over time.

The results of these tests are illustrated in the following figures:

- **Figure 03:** CUSUM Test
- **Figure 04:** CUSUMQ Test





Based on the previous figures, since the curves for both the **CUSUM** and **CUSUMQ** tests lie within the 5% confidence boundaries, it can be concluded that both models, for the long-term and short-term relationships, exhibit no structural changes. This indicates that the model has structural stability, reinforcing confidence in the accuracy of its estimations and results over both short and long terms.

5. Conclusion

In this research paper, we studied the relationship between the independent variables (agricultural exports, agricultural imports, and the growth rate of value-added in the agricultural sector) and the dependent variable (GDP) in Algeria. This study was based on cointegration methodology and the Error Correction Model (ECM) for the period (2000–2020). The findings from testing the study hypotheses can be summarized as follows:

- **First Hypothesis: The necessity of developing the agricultural sector**
  Through theoretical and applied analysis, the importance of agricultural sector development was confirmed as a necessity to improve overall productivity, contributing to economic growth and sustainable development. (Hypothesis confirmed).
- **Second Hypothesis: Increased agricultural productivity leads to higher GDP levels**
  The econometric study demonstrated that an increase in agricultural productivity by one unit results in a GDP increase of more than **1012.1 units**, **(Hypothesis confirmed).**
- **Third Hypothesis: The existence of a long-term relationship between agricultural production and GDP**
  The analysis results showed a positive long-term relationship between agricultural production and GDP, consistent with most previous studies that confirmed a positive correlation between agricultural productivity and economic growth. (Hypothesis confirmed).

Study Results

This study led to several significant findings, divided into two main aspects: theoretical and applied.

First: Theoretical Results

1. **Agricultural Policies in Algeria:**
   Algeria has adopted numerous policies and strategies to advance the agricultural sector. However, the sector's contribution to GDP remains low, estimated at only 3%.
2. **Importance of the Agricultural Sector in Economic Development:**
   The agricultural sector plays a pivotal role in development by:
   - Providing job opportunities for rural populations.
   - Securing food and raw materials for local industries.
   - Supporting exports and reducing imports, contributing to an improved trade balance.
3. **Gradual Development of Agricultural Policy:**
   Agricultural policies in Algeria have gradually evolved to meet the increasing demand for food, focusing on improving living standards in rural areas.
4. **Climatic Challenges:**
   The agricultural sector in Algeria remains heavily reliant on natural and climatic conditions, highlighting the need for sustainable agricultural strategies adapted to these challenges.
5. **Characteristics of Time Series:**
   The Augmented Dickey-Fuller (ADF) test confirmed that the time series used are integrated of order one I(1), supporting the application of the cointegration approach using the ARDL model.
6. **Bounds Test Results:**
   The Bounds Test indicated the existence of a cointegration relationship between the real effective exchange rate of the Algerian dinar and its determinants, supporting structural stability in the long-term relationship.

Second: Applied Results

1. **Existence of a Long-Term Relationship:**
   Long-term model estimates confirmed a positive relationship between agricultural exports and GDP. Increasing agricultural exports directly contributes to enhancing economic growth.

2. **Challenges Related to Exports:**
   Despite the importance of agricultural exports, the Algerian economy remains heavily reliant on hydrocarbons, which account for 97% of total exports. This reliance exposes the economy to fluctuations resulting from changes in global oil prices.

Recommendations

Based on the study findings, the following recommendations are proposed:

1. **Enhancing Government Support for the Agricultural Sector:**
   - Establish effective mechanisms to direct government support toward agricultural investment, as this support is crucial for the success of any agricultural policy in achieving its objectives.
   - Agricultural investment should be a primary tool for stimulating economic growth and improving productivity.

2. **Supporting Small and Medium Enterprises (SMEs) in Exporting:**
   - Focus on providing necessary support to SMEs involved in exports, as these enterprises are key to increasing non-hydrocarbon export values.
   - Offer financial and administrative facilities to encourage these enterprises to expand into international markets.

3. **Promoting Agricultural Scientific Research:**
   - Position agricultural scientific research as a cornerstone for improving productivity and achieving sustainability.
   - Develop intensive applied programs for agricultural research and encourage innovation through investment in scientific capacities, offering proper training and development for sector employees.
   - Strengthen agricultural extension services to disseminate knowledge and apply modern techniques on a wider scale.

4. **Developing the Food Industries:**
   - Work on developing food industries to absorb surplus agricultural products and transform them into marketable goods.
   - Encourage the export of agricultural goods, especially products with production surpluses, while focusing on improving product quality to meet global market requirements.

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