

## ***The impact of the agricultural sector on non-hydrocarbon economic growth in Algeria (1995-2023): An ARDL approach***

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### ***Abstract:***

*This study aimed to examine the impact of the agricultural sector on non-hydrocarbon economic growth in Algeria during the period 1995–2023. To achieve this objective, a descriptive methodology was employed to explore the theoretical foundations related to the agricultural sector and non-hydrocarbon growth, alongside a quantitative approach using the Autoregressive Distributed Lag (ARDL) model to measure the relationship between the study variables.*

*The study found a statistically significant negative relationship between non-hydrocarbon economic growth and agricultural value added in both the short and long term. These findings highlight the need for Algeria to adopt a more comprehensive and diversified economic strategy to strengthen development and reduce structural dependence on the hydrocarbon sector.*

***Key Words:*** *Agricultural sector; Non-Hydrocarbon economic growth; Agricultural investment; ARDL Model.*

***JEL Classification:*** *O11, Q13, C51.*

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## **1. Introduction**

To overcome the structural challenges facing the Algerian economy, particularly its excessive dependence on hydrocarbon revenues, an urgent need has emerged to adopt a more diversified and sustainable economic model. The agricultural sector stands at the forefront as one of the promising alternatives capable of contributing effectively to this transformation, given its natural, human, and institutional potential.

The agricultural sector is not considered just as driving force of the alternative sectors and one of the pillars of Algeria's economic diversification strategy. But it also serves as a fundamental source for achieving food security and provides other sectors with many raw materials that can help expand the productive base of the national economy. In addition, it contributes significantly to absorbing a significant share of the unemployed population.

Since the early years of independence, the Algerian authorities have given great importance and a special status to this sector among the priorities of economic development. Several programs and policies have been adopted to promote the agricultural sector and achieve sustainable economic development by encouraging agricultural investment, as it is one of the most important tools for implementing agricultural development programs. These, in turn, help increase productive capacities, thereby boosting capital formation rates and increasing non-hydrocarbon growth rates.

In light of the aforementioned context, the core research problem addressed by this study is: **To what extent has the agricultural sector contributed to enhancing non-hydrocarbon economic growth in Algeria during the period 1995–2023?**

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

- What structural developments has the Algerian agricultural sector undergone in relation to non-hydrocarbon economic growth during the period 1995-2023?
- To what extent have fluctuations in agricultural investment affected non-hydrocarbon economic growth in Algeria during the period 1995–2023?
- Does a long-run equilibrium relationship exist between agricultural sector and non-hydrocarbon economic growth?

Based on the study problem and its sub-questions, and in light of the Autoregressive Distributed Lag (ARDL) model adopted in the analysis, the following hypotheses are proposed for econometric testing:

**First hypothesis:** There is a statistically significant positive relationship between the added value of the agricultural sector and the non-hydrocarbon economic growth rate in Algeria during the period 1995–2023.

**Second hypothesis:** There is a statistically significant positive relationship between the value of agricultural investment and the non-hydrocarbon economic growth rate in Algeria during the period 1995–2023.

### **1.1. Significance of the study**

The importance of this study stems from its expected contributions at both the academic and practical levels, by measuring the extent to which the agricultural sector contributes to enhancing non-hydrocarbon economic growth in Algeria during the period 1995–2023, and the sector's capacity to create added value that supports the diversification of the Algerian economy and reduces dependence on the hydrocarbon sector.

### **1.2 Study objectives**

This study aims to achieve the following objectives:

- To explore the current state of the agricultural sector in Algeria during the period 1995–2023;
- To assess the impact of the agricultural sector on non-hydrocarbon economic growth in Algeria during the study period.

### **1.3 Literature review**

A substantial body of literature emphasizes the important role of the agricultural sector in economic growth, where agriculture is viewed as a key driver of economic diversification and sustainable economic development:

- Zakaria Bellabaci, Farida Azzazi, (2024), The impact of the agricultural sector on the gross domestic product in Algeria - An econometric study for the period (2000–2020), European economic letters, Volume 14, Issue 4.

This study aimed 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.

- Khedir Soufiane, Ahmima Khaled, (2024), Agricultural sector and its impact on economic growth in Algeria, Journal of informatics education and research, Volume 4, Issue 2.

This study aimed to highlight the role of the agricultural sector as a fundamental contributor to economic growth in Algeria and assess its response to key reforms and various forms of support. It adopted a mixed methodology combining quantitative and qualitative analysis. Findings indicate that the sector remains vulnerable to climate change, suffers from a declining labor interest, and lacks a clear administrative system. Additionally, there is a significant gap between Algeria's food and agricultural imports and exports, with food export coverage of imports not exceeding 6.2% during the study period.

- Guenouna lakhdar, (2024), Measuring the impact of investment on agricultural growth in Algeria during the period 2000-2022 using ARDL, New economy journal, Volume 15, Issue 2.

This study aimed to examine the co-integration relationship between agricultural investment and agricultural growth during the period 2000–2022, using the Autoregressive Distributed Lag model to analyze the dynamics of this relationship. The results revealed that agricultural investment did not have a significant impact on agricultural growth in the short run. However, there was a statistically significant and positive effect of agricultural investment on per capita agricultural output. Specifically, a one-unit increase in agricultural investment leads to a 0.98-unit increase in per capita agricultural output. These findings highlight the importance

of the agricultural sector in fostering economic growth and creating job opportunities, particularly in the context of effective agricultural reforms implemented by the state.

- Gherbi, Rachid; Bouabdelli, Yacine, (2023), Investment in the agricultural sector to promote economic growth outside the hydrocarbon sector in Algeria during the period (2021-1980)-An econometric and analytic study using the Ardl model -, Economic studies journal, Volume 17, Issue 3.

This study aimed to highlight the importance of investment in the agricultural sector and its role in promoting economic growth outside the hydrocarbon sector in Algeria, as a strategic choice to achieve sustainable economic development during the period (1980- 2021), by using the Autoregressive Distributed Deceleration Lag (ARDL) model to reveal the existence of a relationship between economic growth and the variable that explains it. The econometric study concluded that there is a long-term equilibrium relationship that goes from the explanatory variable towards the dependent variable, in addition to the absence of the problem of autocorrelation of serial errors as well as the stability of estimates over time, which explains the stability of the economic growth equation during the study period.

- Hammache, Souria, (2022). The contribution of agricultural and manufacturing sectors to non-oil economic growth in Algeria: An empirical analysis, Economics researcher's journal, Volume 9, Issue 1.

The study aimed to examine the contribution of the agriculture and the manufacture sectors to non-oil economic growth in Algeria. We have applied the ordinary least square (OLS) method, during the period 1999-2021. The findings suggest the existence of a significant and positive influence of agriculture value added on non-oil-economic growth in Algeria. The second result confirms the negative influence of the manufactured value added on Algerian economic growth. This result could be explained by the inefficiency of the Algerian industry. The Algerian economic diversification could be achieved by developing the two sectors.

#### **1.4 Research methodology and approach**

To address the research problem and test the hypotheses the study adopted a descriptive-analytical approach to examine the concepts, dimensions, and implications of the study variables. Additionally, an econometric methodology is applied by using the Autoregressive Distributed Lag (ARDL) model to estimate the relationship between the study variables, as this model does not require all variables to be stationary at the same order. In other words, it can be used when variables are integrated at level  $I(0)$  and/or  $I(1)$ , provided that the dependent variable is not stationary at level. The model is also appropriate for small sample sizes and enables the estimation of both short-term and long-term relationship components within a single equation. (Benjouad & Kourtel, 2019, pp. 314-315)

#### **2. The non-hydrocarbon sector in Algeria**

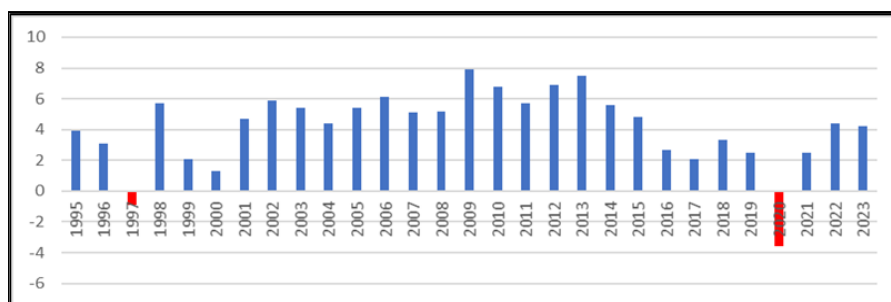
The contribution of the hydrocarbon sector to the Algerian economy represents one of the most prominent characteristics of the economic structure, constituting a principal component of gross domestic product, public revenues, and export composition. Given the severe fluctuations that characterize the prices of these resources in global markets, any external shock generates negative repercussions on internal economic equilibrium and creates substantial challenges that are difficult to confront or mitigate. Consequently, it has become imperative to adopt an alternative economic model that relies on a balanced approach across diverse economic sectors

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(industry, agriculture, commerce, and services). This transition aims to achieve a diversified economy that facilitates comprehensive economic development through ensuring stable and sustainable growth rates. To achieve this objective, it is essential to work towards attaining high and stable growth rates in the non-hydrocarbon sector.

The following figure illustrates the historical evolution of growth rate for this sector during the study period:

**Fig.1.** Non-hydrocarbon economic growth (%)



**Source:** Prepared by the researcher according to the national accounts reports published by the national office of statistics.

Figure 1 demonstrates that the growth rates of the non-hydrocarbon sector were predominantly positive, averaging 4% throughout the study period. These rates ranged between a peak of 7.5% in 2013 and a minimum of -3.6% recorded in 2020, which coincided with the outbreak of the COVID-19 pandemic and its consequent negative repercussions that severely impacted economic activity. Additionally, a negative growth rate of 0.9% was recorded in 1997.

It is also observable that periods of increased growth in the non-hydrocarbon sector correspond with periods of rising prices of natural resources (oil & gaz) in international markets. This correlation shows that the growth of other economic activity sectors remains heavily dependent on hydrocarbons sector, which, as previously mentioned, serves as a primary source of public revenues. This dependency constitutes a significant impediment to the adoption of long-term development strategies, thereby further diminishing the growth prospects of alternative sectors, particularly the agricultural sector, which possesses considerable potential to contribute substantially to comprehensive development, given Algeria's advantageous geographical, natural, and human resource endowments.

### **3. The agricultural sector in Algeria**

The agricultural sector occupies paramount importance in national economies, contributing at varying rates to enhancing economic growth through measurable increases in gross domestic product via the value added it generates, thereby reflecting positively on overall macroeconomic development. (Benjouad & Kourtel, 2019, p. 305). In Algeria, however, the agricultural sector is considered one of the most pivotal sectors in the country's economic development process, given its substantial inherent capabilities. Consequently, agricultural policies implemented ranging from self-management and the agrarian revolution to the agricultural and rural renewal policy, encompassing the agricultural and rural development plan have aimed to advance agricultural and rural development, particularly in rural territories. These policies position the agricultural sector as a crucial stabilizing mechanism through its impact on

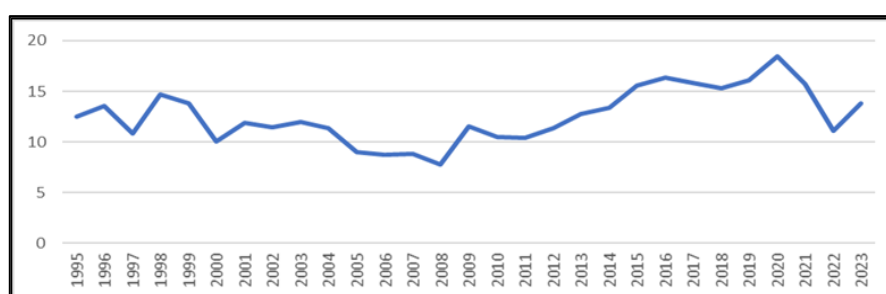
gross domestic product and enhancement of crop and livestock production and productivity, which enables reduction of food import expenditure, achievement of food security, contribution to employment creation, and mitigation of rural unemployment. (Souici, Jorfi, & Faouzi, 2023, p. 280)

### 3.1 The agricultural added value

The term "agricultural added value" generally refers to manufacturing processes that increase the value of primary agricultural commodities. Similarly, the concept of agricultural added value can refer to enhancing the economic value of a commodity through specific production processes, such as organic products or products bearing regional trademarks that increase consumer appreciation and willingness to pay a price premium over similar products that cannot be preferred over them. It can also be considered as the process that aims to increase the value of agricultural products by integrating additional steps or processes beyond their basic production. Its objective is to increase the economic return for farmers and other stakeholders in the agricultural supply chain through producing goods with higher market value. This concept may involve transforming raw agricultural materials into processed or finished goods that meet specific consumer demands and preferences. So agricultural added value serves as an important strategy for agricultural entrepreneurship and rural development through numerous programs that support the efforts of entrepreneurs and communities in the field. (Messani, 2023, p. 78)

The following figure illustrates the historical evolution of the agricultural sector's value added throughout the study period.

**Fig.2.** The agricultural added value as a percentage of total value added during the period 1995–2023 (%)



**Source:** Prepared by the researcher according to the national accounts reports published by the national office of statistics.

From Figure 2, the average contribution of agricultural value added as a percentage of total value added across all sectors reached approximately 12.5% during the study period. This contribution ranged between a minimum value of 7.8% recorded in 2008 and a maximum value of 18.45% registered in 2020.

The observed increase in the percentage of agricultural value-added in recent years is attributed to financial institutions and planned programs to encourage farmers to invest. Among the most important programs was the national agricultural development Plan (PNDA), which entered into implementation in the second half of 2000. In 2002, this plan was expanded to include rural areas and became the national agricultural and rural development plan (PNDAR), as rural areas suffer from deprivation and poverty due to low farmer incomes and the inability of agricultural activity to meet their needs, alongside the deterioration of agricultural investments

after the state's privatization of the agricultural sector. The plan also relies on reviving the dynamics of rural areas with the aim of stabilizing residents in their lands and involving them in the development process, thus working to reduce rural exodus. Then, in 2012, a group of funds were merged into a special fund for the rural development program (FNDR) under account 140-302, with the forest director being directly responsible for it. Under this fund fall three sub-funds: the rural development and land reclamation fund through concessions (FDRMVTTC), the desertification control and pastoral economy and steppe development fund (FLDDPS), and the special fund for supporting livestock breeders and small agricultural operators (FSAEPEA). A special fund for agricultural development (FNDA) was also created under account 139-302, with the director of agricultural services being responsible for it. Under this fund fall three funds: the national agricultural investment development fund (FNDIA), the Animal Health Promotion and plant protection fund (FPZPP), and the national agricultural production control fund (FNRPA). (Mehdaoui & Moussaoui, 2023, p. 454)

### **3.2 The agricultural investment**

Agricultural investment represents the integration of available production factors in agriculture (land, labor, and capital) and their deployment for the purpose of producing agricultural materials to meet consumer needs and achieve optimal value added. This principle was articulated at the earth summit on environment and development held in Rio de Janeiro, Brazil, in 1992, under the theme "Earth in Our Hands" To establish the nexus between agricultural development objectives, particularly the goal of eliminating hunger and achieving sustainable development, substantial increases in agricultural investment and improvements in its quality must be ensured. Investment in this sector will unlock extensive prospects for economic and agricultural activity and contribute to realizing multiple benefits: (Mezellef & Chelihi , 2020, pp. 242-243)

- Enhancing agricultural production through optimal utilization of natural resources;
- Improving the performance and efficiency of the agricultural sector and establishing new agricultural projects;
- Progressively introducing technological innovations related to agricultural techniques;
- Increasing the export ratio of agricultural products that were previously imported;
- Expanding employment in the agricultural sector, thereby engaging substantial labor force and alleviating unemployment through the creation of new employment opportunities.

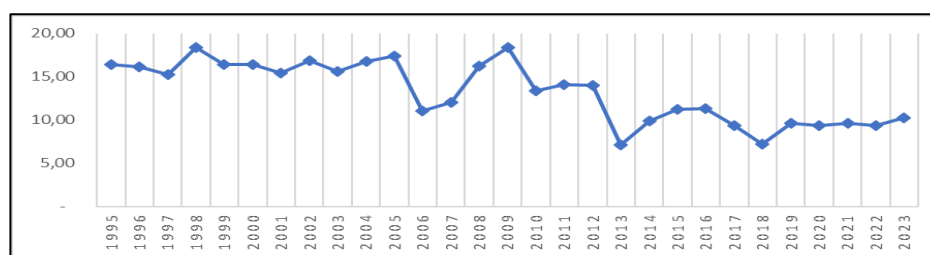
In order to achieve these benefits in reality, basic requirements must be available to help adopt highly effective and efficient agricultural strategies. These requirements can be summarized as follows: (Gherbi & Bouabdelli, 2023, pp. 183-184)

- Arable land and labor: The availability of arable land and labor represents the fundamental element for agricultural investment, which depends on the availability of water and rainfall rates. The availability of agricultural labor in rural areas also allows for reducing labor costs in agricultural production;
- Livestock resources: The availability of diverse livestock resources is considered one of the requirements for agricultural investment, as it provides enormous numbers of livestock in addition to the existence of vast areas of natural pastures that can be developed to provide more animal feed. This is in addition to the possibility of raising animals alongside plant production;

- *Determining the type of agricultural production*: determining the type of agricultural production is considered one of the requirements for agricultural investment, within the framework of the economic and social orientations of each country or its medium and long-term development plans. This makes the process of determining production type linked to identifying investment projects for these environments, which enables creating regional balance in agricultural activities according to environmental zones;
- *Determining appropriate technology for agricultural production*: Using appropriate technology in agricultural production is considered one of the requirements for agricultural investment, as it is a complex process and also to keep pace with the rapid development in technology production at the global level. The concept of technology includes production inputs such as improved seeds, soil fertilizers, insecticides, and a schedule for cultivation, cleaning, and harvesting, in addition to machinery and equipment that enable soil preparation at the appropriate time;
- *Agricultural finance*: The necessity of creating and expanding rural banks and purpose cooperatives, which would achieve two advantages:
  - First advantage: Providing necessary information to banks and purpose cooperatives about farmers' conditions and capabilities, which serves as collateral for loans alongside their contribution to attracting farmers' savings;
  - Second advantage: Facilitating access to agricultural credit sources away from all bureaucratic procedures;
- *Agricultural marketing*: The necessity of creating and expanding rural markets to enable farmers to market their production surplus, with the need to focus on improving and reducing transportation, marketing, storage, and monopoly costs, which would raise agricultural productivity. Working to liberalize agricultural product prices, as the relationship between agricultural product prices and the prices at which farmers buy their production requirements directly affects the nature, quality, and volume of what they can produce. Agricultural product selling prices are also a factor that determines agricultural sector costs because they greatly affect agricultural production.

The following figure shows the historical evolution of the agricultural sector's investment throughout the study period.

**Fig.3.** Agricultural investment as a percentage of total investment for period 1995–2023 (%)



**Source:** Prepared by the researcher according to the national accounts reports published by the national office of statistics.

Figure 3 shows that the average agricultural investment as a percentage of total investment reached approximately 13.27% during the study period. It ranged between its lowest value of

7.15% in 2013 and its highest value recorded in 2020 at 18.40%. It is notable that the agricultural investment ratio has declined significantly since 2013 until 2023, where it did not exceed 10% in most years.

### **3.3 Supporting and promoting agricultural investment**

Algeria seeks through its various policies and recently enacted laws, particularly those related to encouraging investment such as the new investment law No. 22-18 issued on July 24, 2022, to focus on openness to ensure food security regarding strategic sectors initially, ultimately encompassing all other sectors. This is achieved through various measures and incentive systems that have been adopted to support, ensure growth, and strengthen it, which include: (Aberkane & Belhadj, 2023, p. 173)

- Transforming the national investment development agency (ANDI) into the Algerian investment promotion agency (AAPI), which will handle the management of investment portfolios whether national or foreign, aimed at promoting investment in Algeria through preparing promotion plans and determining the financial amounts necessary to implement them. Additionally, it will establish and manage the digital platform dedicated to investors, which focuses on evaluating the investment climate, monitoring and supervising various investments and directing them from registration on the platform level to the exploitation stage by collecting and providing various investment-related information, particularly regarding investment opportunities;
- Establishing and allocating a single window for monitoring major investment projects exceeding 2 billion dinars in value and foreign investments, enjoying national specificity unlike decentralized single windows aimed at helping and accompanying local investors in establishing procedures related to their investments to enjoy local jurisdiction. Therefore, materializing these types of major projects and their success will lead to creating many job positions, thus increasing wealth, contributing to import substitution and export diversification;
- Benefiting from numerous advantages related to investment and its accompanying services through a group of incentive systems including a special rights system for priority sectors such as agriculture (during implementation phase: exemption of imported goods entering investment implementation from customs duties and value-added tax), another specific to regions given special importance by the state (such as sites where natural resources can be valorized), and another specific to structured investments (investments valued at over 10 billion dinars whose qualification criteria are determined by regulation);
- Ensuring freedom to establish an investment project by foreign investors, now called non-resident investors, without needing partnership with Algerian investors, thus allowing them the opportunity to access the Algerian market with complete ease, in addition to the possibility of partial or even complete transfer of investment project activities from abroad to Algeria;
- Possibility for investment projects included in the list of projects eligible for incentive systems to benefit from state-owned land;
- Reinvestment of the estimated amount of 30% of credits and reductions under corporate profit tax and professional activity tax within a time period of 4 years, in case of accumulation of tax advantage amounts related to these years, according to several forms including capital contribution in startup companies or incubator companies. Tax advantages specific to companies

established through partnerships between public or private companies and foreign companies are excluded from the aforementioned reinvestment;

- Including contractors whose annual turnover does not exceed 5 million dinars under the basic law of self-employed contractors No. 22-23 dated December 18, 2022, subjecting them to a single lump-sum tax of 5% of turnover regardless of their activity nature;
- Authorizing customs clearance of agricultural equipment and machinery not exceeding 7 years old, as well as used production lines and equipment less than 5 years old due to their depreciation

#### 4. Econometric study

##### 4.1 Structure of the econometric model and time series characteristics

##### 4.1.1 Structure of the econometric model

Based on previous studies and the characteristics of both the Algerian economic structure and the agricultural sector, the non-hydrocarbon economic growth rate (NHEGR) was taken as the dependent variable for the study period (1995–2023), while the following independent variables were adopted:

- The value added of the agricultural sector (AGRIVA);
- Agricultural investment (AGRINV).

In order to measure the impact of the agricultural sector on non-hydrocarbon economic growth in Algeria during the period 1995-2023, we started from a basic hypothesis stating that there is a positive impact of the agricultural sector on the level of non-hydrocarbon economic growth in Algeria. Based on this, the model formulation is as follows:

$$NHEGR = a_0 + a_1 AGRIVA + a_2 AGRINV + \mu_i \quad (1)$$

Where:

$a_0, a_1, a_2$ : represent the parameters of the econometric model;

$\mu_i$ : represents the random error term, or the model residuals.

The data were collected from the National Office of Statistics, the World Bank database, Bank of Algeria and reports from the Ministry of Finance. According to previous studies as (Guenouna, 2024) and (Bellabaci & Azzazi, 2024) the Autoregressive Distributed Lag (ARDL) model originally developed as an alternative to traditional cointegration techniques (Pesaran, Shin, & Smith, 1999) was used. This methodology differs from conventional approaches in that it does not require all variables to be integrated of the same degree; it can be applied when variables are integrated of degree I(0) and I(1), as long as the dependent variable is not I(2). It is also suitable for small sample sizes and allows for the estimation of both short-run and long-run dynamics within a single equation. The model assumes that the time series of the dependent variable is a function of its lagged values, the current values of the explanatory variables, and their lagged values over one or more periods. (Benjouad & Kourtel, 2019, pp. 314-315)

The general form of the ARDL model is expressed as follows: (Ghafouri & Ramli, 2023, p. 208)

$$\Delta Y_t = C + \{ \sum_{i=1}^n \beta_{1i} \Delta Y_{t-i} + \sum_{i=0}^{q_1} \delta_2 \Delta X_{t-i} \} + \{ \varphi_1 Y_{t-1} + \varphi_2 X_{t-1} \} + \mu_t \quad (2)$$

Where:

$Y$ : is the dependent variable;

$X_1, X_2, \dots, X_k$ : are the explanatory variables;

$q_1, q_2, \dots, q_k$ : are Lag periods for explanatory variables  $X_1, X_2, \dots, X_k$  respectively;

$C$ : is the constant;

$\beta, \delta$ : are the parameters of the short-run dynamic relationship;

$\phi_1, \phi_2$ : are the parameters of the long-run equilibrium relationship;

$\Delta$ : represents the first difference of the variables values;

$\mu_t$ : is the error term.

#### **4.1.2 Time series characteristics**

To assess the stationarity of the time series, the Augmented Dickey-Fuller (ADF) test was applied. This test evaluates the presence of unit roots in the time series variables by examining the null hypothesis ( $H_0: \phi = 1$ ), which suggests that a unit root exists and, therefore, that the series is non-stationary. This is tested against the alternative hypothesis ( $H_1: \phi < 1$ ), which indicates the absence of a unit root, implying that the series is stationary. (Dickey & Fuller, 1979, p. 431) The results presented in Table 1 indicate that the time series for non-hydrocarbon economic growth and the agricultural value added are stationary at first difference, they are integrated of order one  $I(1)$ . In contrast, the time series for agricultural investment is stationary at level, integrated of order zero  $I(0)$ .

**Table 1:** Augmented Dickey-Fuller test results for the time series

| The Variables | At level              | At first difference   | Degree of Stationarity |
|---------------|-----------------------|-----------------------|------------------------|
|               | With Constant & Trend | With Constant & Trend |                        |
|               | Prob                  | Prob                  |                        |
| <b>NHEGR</b>  | <b>0.1184</b>         | <b>0.0000</b>         | <b>I(1)</b>            |
| <b>AGRIVA</b> | <b>0.3500</b>         | <b>0.0016</b>         | <b>I(1)</b>            |
| <b>AGRINV</b> | <b>0.0182</b>         | <b>/</b>              | <b>I(0)</b>            |

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

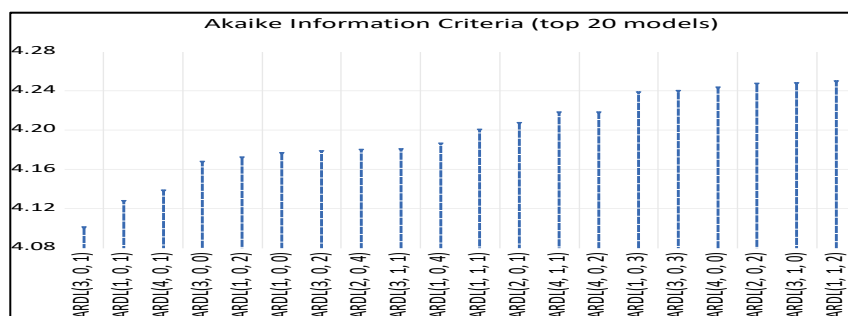
In order to verify the potential existence of a co-integration relationship among the variables of the estimated model, the Bounds Test was employed, as shown in Figure 1. The calculated F-statistic value exceeds all the critical values at the various significance levels. Accordingly, the null hypothesis, which states that there is no co-integration among the variables is rejected in favor of the alternative hypothesis, which confirms the existence of a co-integration relationship.

**Fig.4.** Bounds test results

| F-Bounds Test    |               | Null Hypothesis: No levels relationship |      |      |
|------------------|---------------|-----------------------------------------|------|------|
| Test Statistic   | Value         | Signif.                                 | I(0) | I(1) |
| F-statistic<br>k | 5.714112<br>2 | Asymptotic: n=1000                      |      |      |
|                  |               | 10%                                     | 2.63 | 3.35 |
|                  |               | 5%                                      | 3.1  | 3.87 |
|                  |               | 2.5%                                    | 3.55 | 4.38 |

**Source:** Outputs of Eviews 12 software.

Regarding the determination of optimal lag structure, the Akaike Information Criterion (AIC) was utilized as the primary model selection criterion. The empirical findings reveal that the optimal model specification corresponds to an ARDL (3, 0, 1) framework, which exhibits the minimum AIC value among all candidate models examined. This specification demonstrates superior goodness-of-fit relative to alternative lag configurations, thereby constituting the most statistically robust representation of the underlying data-generating process.

**Fig.5.** Akaike information criteria test results

**Source:** Outputs of Eviews 12 software.

## 4.2. Estimation and testing of the econometric model

### 4.2.1 Estimation of the study model

The next step involves estimating the model and assessing its overall adequacy and goodness of fit.

#### 4.2.1.1 Estimation of long-run parameters

We begin by estimating the long-run parameters. As shown in Table 2, the estimated parameters indicate the existence of a statistically significant negative long-run relationship between the non-hydrocarbon economic growth rate and the agricultural value added. Where, a 1% increase in AGRIVA leads to a 0.85% decrease in the NHEGR, this is inconsistent with economic theory. While the relationship between the non-hydrocarbon economic growth rate and agricultural investment was negative and not statistically significant, as an increase in AGRINV value by 1% leads to a decrease in the NHEGR by 0.08%, which contradicts economic theory. Meanwhile, the constant value (c) was 16.31 and significant, which suggests the existence of other variables that explain the model beyond those included.

**Table 2:** Long-run parameter estimation results

| Levels Equation                          |
|------------------------------------------|
| Case 2: Restricted Constant and No Trend |

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| Variable                                               | Coefficient | Std. Error | t-Statistic | Prob.  |
|--------------------------------------------------------|-------------|------------|-------------|--------|
| AGRINV                                                 | -0.08501    | 0.148033   | -0.574283   | 0.5725 |
| AGRIVA                                                 | -0.85937    | 0.230289   | -3.731726   | 0.0014 |
| C                                                      | 16.31816    | 4.155302   | 3.927070    | 0.0009 |
| EC = NHEGR - (-0.0850*AGRINV -0.8594*AGRIVA +16.3182 ) |             |            |             |        |

Source: Outputs of Eviews 12 software.

#### ***4.2.1.2 Estimation of the short-run relationship within the unrestricted error correction model (UECM)***

Table 3 presents the short-run estimation results of the impact of the agricultural sector on non-hydrocarbon economic growth. The error correction term (ECT) is negative (-0.7894) and statistically significant at the 1% significance level. This indicates the presence of a long-run equilibrium relationship among the variables in the short run. Specifically, approximately 78.94% of the short-term deviations in non-hydrocarbon economic growth from its long-run equilibrium level in the previous period (t-1) are corrected in the current period (t) in response to changes in the explanatory variables.

**Table 3:** Estimation of the unrestricted error correction model (UECM)

| ECM Regression                           |             |            |             |        |
|------------------------------------------|-------------|------------|-------------|--------|
| Case 2: Restricted Constant and No Trend |             |            |             |        |
| Variable                                 | Coefficient | Std. Error | t-Statistic | Prob.  |
| D(NHEGR(-1))                             | -0.158431   | 0.139325   | -1.137127   | 0.2696 |
| D(NHEGR(-2))                             | -0.293457   | 0.125155   | -2.344759   | 0.0301 |
| D(AGRIVA)                                | -0.178973   | 0.157191   | -1.138570   | 0.2690 |
| CointEq(-1)*                             | -0.789450   | 0.153457   | -5.144449   | 0.0001 |

Source: Outputs of Eviews 12 software.

#### ***4.2.2 Testing the study model***

After estimating the study model, we proceed to the stage of evaluating its adequacy through:

##### ***4.2.2.1 Test of the goodness-of-fit and statistical significance of the model***

The Durbin-Watson statistic in Figure 6 indicates the absence of spurious regression, and the relatively high value of R-squared (68%) means an acceptable explanatory power of the model.

**Fig.6.** Goodness-of-fit and statistical significance of the model test results

|                    |           |                       |          |
|--------------------|-----------|-----------------------|----------|
| R-squared          | 0.687860  | Mean dependent var    | 0.196154 |
| Adjusted R-squared | 0.645296  | S.D. dependent var    | 2.635068 |
| S.E. of regression | 1.569369  | Akaike info criterion | 3.879863 |
| Sum squared resid  | 54.18425  | Schwarz criterion     | 4.073416 |
| Log likelihood     | -46.43822 | Hannan-Quinn criter.  | 3.935599 |
| Durbin-Watson stat | 1.886774  |                       |          |

Source:Outputs of Eviews 12 software.

#### 4.2.2.2 Autocorrelation test of the residuals

The results presented in Table 4 show that the p-value associated with the F-statistic exceeds the 5% significance level. Consequently, the null hypothesis ( $H_0$ ), which states that there is no autocorrelation among the residuals, is accepted.

**Table 4:** Breusch-Godfrey test results for residual autocorrelation

| Breusch-Godfrey Serial Correlation LM Test: |          |                     |        |
|---------------------------------------------|----------|---------------------|--------|
| F-statistic                                 | 0.710121 | Prob. F(4.15)       | 0.5976 |
| Obs*R-squared                               | 4.139606 | Prob. Chi-Square(4) | 0.3874 |

Source: Outputs of Eviews 12 software.

#### 4.2.2.3 Heteroskedasticity test

The results presented in Table 5 indicate that the p-value associated with the F-statistic exceeds the 5% significance level. Therefore, the null hypothesis, which states that the conditional variance of the residuals is homoscedastic, is accepted. This implies that the model does not suffer from the problem of heteroskedasticity and is thus considered adequate in this regard.

**Table 5:** ARCH test results for heteroskedasticity

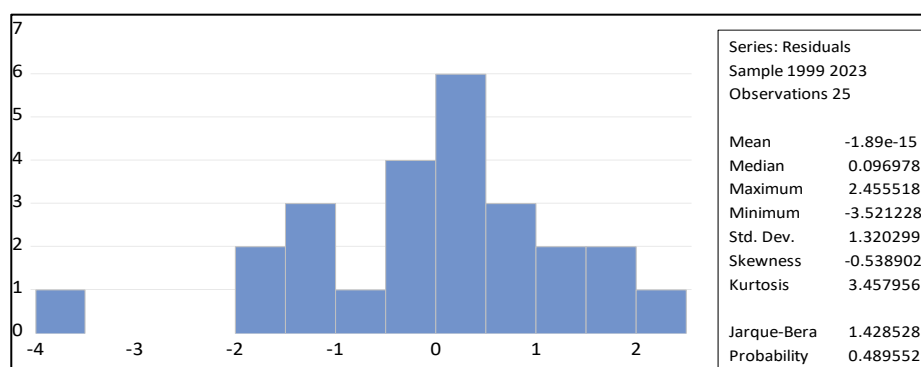
| Heteroskedasticity Test: ARCH |          |                     |        |
|-------------------------------|----------|---------------------|--------|
| F-statistic                   | 0.629065 | Prob. F(4.17)       | 0.6484 |
| Obs*R-squared                 | 2.836494 | Prob. Chi-Square(4) | 0.5855 |

Source: Outputs of Eviews 12 software.

#### 4.2.2.4 Normality test of the residuals

Figure 7 shows that the p-value corresponding to the Jarque-Bera test exceeds the 5% significance level. Therefore, the null hypothesis ( $H_0$ ), which states that the model's residuals are normally distributed, is accepted.

**Fig.7.** Results of the normality test of the residuals

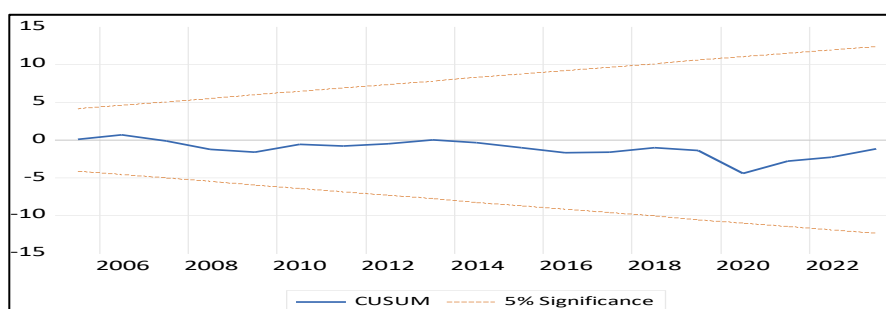


Source: Outputs of Eviews 12 software.

#### 4.2.2.5 Model stability test

Figure 8 shows that the cumulative sums test (CUSUM) plot remains within the critical bounds at the 5% significance level, indicating that both the short-run and long-run parameters of the estimated model are stable. This further confirms the overall stability of the estimated equation over time.

**Fig.8.** CUSUM test results



**Source:** Outputs of Eviews 12 software.

### 4.3 Empirical results analysis

Through this study, we aimed to examine the impact of the agricultural sector on non-hydrocarbon economic growth in Algeria during the period 1995–2023. This empirical analysis has led to the following key findings:

- The estimation of the relationship among the variables—namely, non-hydrocarbon economic growth, the value added of the agricultural sector, and the agricultural investment in Algeria—was conducted using an econometric model that is considered acceptable from both economic and statistical perspectives;
- The Bounds Test indicates the presence of a long-run equilibrium relationship among the study variables. This implies that the current values of non-hydrocarbon economic growth are influenced not only by their own past values but also by the lagged values of the independent variables included into the econometric model;
- There is no evidence of serial autocorrelation in the residuals, nor is there heteroskedasticity, and the residuals are found to be normally distributed;
- The results of the stability test for the estimated Autoregressive Distributed Lag (ARDL) model indicate that the study data do not exhibit any structural breaks. Furthermore, the short-run parameters are stable and consistent with the long-run parameters, a finding that is confirmed by the CUSUM test.

### 5. Conclusion

This study aimed to examine the impact of the agricultural sector on non-hydrocarbon economic growth in Algeria over the period 1995–2023, using the Autoregressive Distributed Lag (ARDL) approach. Following an overview of the structure of the Algerian economy, its growth patterns, and the state of the agricultural sector, the study proceeded to estimate the model and test its statistical validity. The main findings of the study are as follows:

- The existence of a negative and statistically significant relationship between non-hydrocarbon economic growth rate and agricultural added value in both the long and short term, where every 1% increase in the agricultural added value leads to a 0.85% decrease in non-hydrocarbon economic growth. This contradicts economic theory, where any increase in agricultural sector added value is expected to contribute to increasing non-hydrocarbon economic growth rate. This means rejecting the first hypothesis of this study, which states that there is a significant positive relationship between agricultural sector added value and non-hydrocarbon economic growth rate in Algeria during the period 1995–2023;

- The existence of a negative and statistically insignificant relationship between non-hydrocarbon economic growth rate and investment in the agricultural sector in both the long and short term, where every 1% increase in agricultural investment leads to a 0.08% decrease in non-hydrocarbon economic growth rate. This estimate contradicts economic theory. This means rejecting the second hypothesis of this study, which states that there is a significant positive relationship between non-hydrocarbon economic growth rate and investment in the agricultural sector in Algeria during the study period;
- These results can be explained by the continued dependence of the Algerian economy on the hydrocarbon sector and relying on it even to stimulate and develop other sectors such as the agricultural sector, where the financial allocations directed to this sector are fundamentally sourced from hydrocarbon export revenues;
- Through these results, it becomes clear that non-hydrocarbon economic growth in Algeria is structurally linked to the hydrocarbon sector. Therefore, a more comprehensive approach to economic diversification must be adopted by finding other financing sources that are not affected by fluctuations in hydrocarbon revenues.

The study recommends the continued support of investment in the agricultural sector and the exploration of more effective and innovative support mechanisms to achieve food security and contribute to the enhancement of non-hydrocarbon economic growth. This would, in turn, promote greater economic diversification and reduce dependence on the hydrocarbon sector. The agricultural sector also has the potential to generate new employment opportunities, thereby helping to alleviate high unemployment rates. Furthermore, it can contribute to reducing the food import bill and expanding non-hydrocarbon exports. The study also emphasizes the importance of developing agro-industries, as this would further strengthen the agricultural sector and foster integration across various economic sectors.

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