



Analyzing the Effects of Agricultural Investment on Per-Capita Agrarian Output in Algeria: An Econometric Study (2000-2022)

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Abstract:

This study seeks to examine the correlation between agricultural investment expenditure and per capita agrarian output in Algeria from 2000 to 2022. It will utilize the ARDL model and consider per capita agrarian output as an indicator of food security (measured by GDP-AGR) and Agricultural Public Investment (INV-AGRO) as another indicator.

The research determined that there is no immediate correlation. The analysis demonstrated a significant and enduring correlation between per capita agricultural production and agricultural public investment. This association may be attributed to the lasting impact of agricultural policy. The research also found that there is a positive correlation between agricultural public investment and per capita share. Specifically, for every one-unit increase in agricultural public investment, there is a 0.98-unit increase in per capita share. This confirms the significant role of the agriculture sector in promoting economic development.

Keywords: Food Security; Agricultural Policies; Agricultural Investment; ARDL Model.

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1. INTRODUCTION:

The agricultural sector is considered a highly strategic and viable alternative to the oil industry, and it serves as a fundamental foundation for economic growth. Investing in agriculture is a primary focus for nations aiming to achieve economic development goals, which include increasing the Gross Domestic Product (GDP), ensuring food security, creating employment opportunities, absorbing unemployed labor, expanding export volume, and reducing food imports. Given its vast potential (arable land, skilled labor, financial resources), the agricultural sector in Algeria has been a significant focus since independence, featured prominently in all state-planned strategies and programs to foster agricultural development and contribute to national income and overall economic growth.

1.1. Statement of the Problem:

Since independence, the state has directed investments towards agriculture, endeavoring to elevate this sector through various reforms and programs: autonomous management (1962), the agricultural revolution (1971), the law on agricultural investments, the National Program for Agricultural Development (PNDA), the policy of agricultural and rural renewal (2009-2014), and most recently, the five-year program (2015-2018). These governmental policies and programs underscore the sector's importance and the funds allocated to achieve its growth and prosperity and contribute to comprehensive economic development, including increasing the per capita in the overall agricultural output.

1.2. Research Questions:

From the preceding arises: "How has Governmental Investment in Agriculture Influenced Algeria's Per Capita Agrarian Output Between 2000 and 2022?"

1.3. Hypothesis/ hypotheses:

We propose this hypothesis: "From 2000 to 2022, Enhanced Public Investment in Agriculture in Algeria Positively Correlates with Long-Term Increases in Per Capita Agrarian Output, Contributing to Improved Food Security and Economic Growth."

1.4. Significance of the Study:

The importance of this research is in examining and assessing the path of agricultural investment expenditure in Algeria, including government programs and policies, and its contribution to reaching economic development goals.

This study is crucial since it offers empirical information about the efficacy of agricultural investment strategies in Algeria. Gaining a comprehensive understanding of

this correlation is of utmost importance for formulating effective policies, particularly in improving food security and reducing economic dependence on hydrocarbon resources.

1.5. Objectives of the Study:

The primary aim of the research is to measure the impact of agricultural investment spending on the **per-capita** agricultural output in Algeria from 2000 to 2022.

1.6. methodology of the Study:

The study used the Autoregressive Distributed Lag (ARDL) model to analyze time-series data spanning from 2000 to 2022. In this case, the measure of food security is per capita agricultural production, whereas the significant variable is agricultural public investment. This technique enables a comprehensive examination of immediate fluctuations and enduring equilibrium connections.

1.7. literature review:

This study expands on a body of thorough research investigating the many effects of government expenditure on different economic factors, with a specific emphasis on the agriculture industry in emerging nations such as Algeria.

(Belarbi, Saous, & Mostéfaoui, 2017) Research reveals that public expenditure in Algeria has a favorable impact on employment and consumer expenses. However, it also increases commodity prices, indicating a multifaceted economic consequence of fiscal policies. Similarly, (Messaili & Kaïd Tlilane, 2017) found that public health expenditure had no statistically significant effect on life expectancy and infant mortality. They highlighted the importance of GDP per capita and fertility rate in this context.

(Ramli, Boutayeba, & Nezai, 2022) research did not establish a sustained correlation The relationship between governmental investment in human capital and economic growth. (Allali, Tamali, & Rahli, 2015) they have established a positive and enduring correlation between CO2 emissions and energy use, indicating a possible influence on production. These studies jointly emphasize the intricate and diverse nature of public expenditure and its impact on economic variables in Algeria.

Agriculture-Specific Findings: According to (Mokhtari & Moulay, 2016), government assistance for agriculture has a double effect: it positively influences agricultural development but negatively affects long-term economic growth. This contradictory result highlights the subtle impacts of policies particular to specific sectors.

Econometric methodologies: The study by (Handique, 2020) and (Matthew & Mordecai, 2021) used advanced econometric techniques such as ARDL and Vector Autoregressive models to examine the relationship between agricultural technology and production, as well as the influence of agricultural output on economic development.

Environmental Considerations: In their study, (Chaouachi & Balsalobre-Lorente, 2022) used the autoregressive distributed lag (ARDL) approach to establish a non-linear association, namely an N-shaped environmental Kuznets curve (EKC), between the economic development and ecological footprint in Algeria. This discovery emphasizes the ecological repercussions of monetary policy.

Global viewpoint: (Yazdanpanah, 1994) investigates the impact of oil prices on food security in nations like Algeria, Iran, and Saudi Arabia from a global perspective. The research uses cointegration and error correction models to examine this link within a global context.

Contribution of the Current Study: This study seeks to expand upon previous studies by explicitly concentrating on Algeria's agriculture industry from 2000 to 2022. Using an ARDL model, The objective of this research is to elucidate the immediate and enduring impacts of agricultural investment spending on per capita agrarian productivity. Consequently, it provides crucial insights into the efficacy of Algeria's agricultural policies. The results will contribute to the current knowledge base and provide practical recommendations for policy development to improve agricultural production and overall economic welfare in Algeria.

1.8. Organization of the Study: To comprehensively cover all aspects of the research, we have divided it into the following sections:

Section One: The theoretical farmwork for food security.

Section Two: Key agricultural reforms in Algeria.

Section Three: Modeling and testing the co-integration relationship between agricultural investment spending and the per capita agricultural output.

2. The theoretical farmwork for Food Security:

2.1 Concept of Food Security:

Food security is a multifaceted concept that encompasses several aspects, including the existence, availability, consumption, and consistency of food provision. Food security, as per the definition provided by the World Food Summit in 1996, pertains to the condition in which each person has constant and dependable access to a sufficient quantity of safe and nourishing food that meets their dietary needs for a healthy and active life. (Reincke, et al., 2018, p. 313). This concept highlights the significance of not only the presence of food but also the ease of obtaining and using food to guarantee a state of well-being and physical activity. Moreover, a Delphi consensus survey emphasized that food security is present when people possess tangible, communal, and financial means to get food that is abundant and of a satisfactory standard to fulfill their dietary requirements and desires, enabling a state of well-being and vitality (Gallegos, Booth, Pollard, Chilton, & Kleve, 2023, p. 1988). This emphasizes the social and economic dimensions of food security, in addition to the physical elements. The notion of food

security is intricately linked to a range of closely related concepts, which are delineated as follows:

A. Food Safety:

Food safety, as defined by the World Health Organization, encompasses the necessary circumstances and standards that must be maintained at all stages of food production, processing, storage, distribution, and preparation to guarantee that the food is secure, dependable, nutritious, and appropriate for human consumption. Food safety encompasses all aspects of the food supply chain, starting with agricultural production and extending to the ultimate consumption by the end consumer. (National Information Agency, 2005, p. 2) Ensuring food safety is crucial for protecting public health and requires efficient supervision to avoid and handle large public catastrophes. Implementing and strengthening regulations regarding food production, transportation, and operation may effectively reduce food safety violations, strengthen social control and supervision of food safety crimes, and decrease the probability of public food safety breaches. (Ding, Qiao, Wang, & Huang, 2022, p. 3). Moreover, comprehending the national values and governance systems regarding food safety may have an impact on the food safety culture and enhance the overall performance in ensuring food safety. To create successful strategies for improving food safety performance, it is crucial to evaluate how food safety regulations and governance systems influence food safety culture (Song, Gholizadeh, & Zhuang, 2022, p. 3421).

B. Food Self-Sufficiency:

Food self-sufficiency is the state in which a community can completely depend on its resources to produce all of its food requirements within its local area. (National Information Agency, 2005, p. 2). The concept of self-sufficiency is broad and vague unless placed in a geographical context. However, with trade liberalization, the idea of food self-sufficiency contrasts with developing food trade relations between nations. Therefore, most researchers use the term 'food security' instead of self-sufficiency. The notions of self-sufficiency and food security have been thoroughly analyzed in several settings, including South Asia, where the achievement of rice self-sufficiency plays a crucial role in guaranteeing food security. (Bishwajit, et al., 2013, p. 4). The importance of accurate financial projections for achieving self-sufficiency in chicken meat production and ensuring food security is underscored by the need to consider global supply and demand rates (Alnafissa, Ghanem, Alamri, Alhashim, & Alagsam, 2021, p. 17127), self-sufficiency may hurt food security by decreasing production efficiency and increasing prices, as shown in international commerce and domestic food policy. Nigeria has undergone a transition from being self-sufficient in food production to being reliant on imports to meet its food needs, necessitating the importation of a substantial amount of food to compensate for shortages. (Nwozor, Olanrewaju, & Ake, 2019, p. 3)

C. Food Security:

Food security, as defined by the World Bank, refers to universal access to an adequate supply of food that is necessary for a healthy and active existence. It

encompasses both the availability of food and the capacity to get it. (Al-Droubi, 2008, p. 288) According to the Food and Agriculture Organization of the United Nations, food security is achieved when every individual has consistent and reliable access to an adequate amount of safe and nutritious food that fulfills their dietary requirements and preferences, enabling them to lead an active and healthy life. (FAO, 2020)

Food security, as defined by the Arab Organization for Agricultural Development, refers to the continuous provision of food that meets the necessary quantities and qualities for the well-being and functioning of every individual in a population. This is achieved by primarily relying on local production, taking advantage of each country's ability to produce food commodities, and ensuring that it is accessible to all members of the population at prices that are affordable based on their incomes and financial capabilities. (Arab Organization for Agricultural Development, 2009, p. 16). Food security encompasses the presence, availability, utilization, and consistency of food, along with the nutritional well-being of people and families. The problem at hand is of global magnitude and requires attention to several elements including the availability of food, sufficient earnings, and the enhancement of agricultural output (Pee & Pérez-Escamilla, 2023, p. 308). To attain food security, it is essential to address the issues of hunger, malnutrition, and the availability of a nutritious diet. (Fredrickson, 2014, p. 313) While increasing the availability of food is important, it is as important to consider individual food security, which requires enough resources, markets, and social support. (Randy, 2016, p. 13). Food security entails ensuring not only the presence of food but also the advancement of adequate nutrition and the elimination of hunger, with the ultimate objective of attaining zero hunger (William, 2023, p. 6). The partnership between the food industry and governmental entities is crucial for enhancing the overall resilience of the food system (Dongxu, 2022, p. 744). Food security is the ultimate goal of guaranteeing that every individual has the means to get nourishing and wholesome food to have a productive and healthy life.

2.2 Pillars and Dimensions of Food Security

The idea of food security encompasses the fundamental principles and accompanying aspects that underpin it.

A. Pillars of Food Security:

Food security is a complex subject that encompasses several components. Traditionally, the idea has been understood according to the four essential characteristics of availability, access, use, and stability. However, recent discussions have highlighted the need to expand these core concepts to include other factors, such as climate change (Guiné, et al., 2021, p. 2732). Ecosystem services are essential for sustaining these pillars by contributing to the production of food, providing resources for livelihoods and income, and permitting the safe and hygienic preparation of food (Richardson, 2010, p. 3525). The abundance of food commodities represents the pillars of food security, their perpetual presence in the market, and their affordability for citizens.

Abundance of Food Commodities: Initially, the focus was on quantity, as demand exceeded the food supply without considering its quality.

Perpetual Presence of Food Commodities in the Market: Subsequently, attention shifted to the quality and type of food, balancing quantity and quality.

Affordability of Commodities for Citizens: The final stage emphasized the health aspects of food or food safety, meaning that food prices should be affordable for everyone, which involves either increasing wages for middle and lower classes or reducing food prices, a decision influenced by the state's political and economic policies. (Slatnia & Arour , 2009, p. 9)

B. Dimensions of Food Security:

Food security is a complex issue intertwined with various dimensions, whether demographic, economic, political, or cultural.

Demographic Dimension: Population growth directly impacts food security. The shift in population distribution between rural and urban areas due to rural migration affects agricultural sectors in rural regions.

Economic Dimension: The economic factor is directly related to food security, encompassed by agricultural production (plant, animal, fish) and food industries contributing to food security. This dimension is an integrated field involving biology, veterinary science, and other areas aiming to maximize food productivity and quality.

Political Dimension: The state is responsible for securing food for all society segments through policies, measures, and decisions to achieve food security, which is vital for poor countries facing crises like famines and malnutrition. The political dimension complements the economic aspect in providing labor and capital to agriculture and food industries and implementing decisions to overcome obstacles in food development.

Cultural Dimension: The cultural impact on food security involves the people's ability to find various ways suitable for their conditions, reflecting their right to self-determination and food. This dimension differs from the others as it is not linked to political decisions or capital investment but rather to the intellectual tendencies and cultural attitudes towards food security, demonstrating people's love for land and agriculture and their determination to overcome economic and political challenges for their principles.

2.3 Indicators of Food Security

The complexity of food security has been shown by its association with measures such as the composite Food Security Index (FSI) and reported sorrow, as shown in studies by (Mutea, et al., 2019) and (Lee, Shin, & Kim, 2020). Food security in agricultural output is measured using both individual indicators and comprehensive assessments (Alekseeva, Mironova, Александрова, Istomina, & Mironova, 2023). The criteria used to assess global food security include per capita food expenditure, food consumption score, and coping strategy index (Akukwe, 2020). Neural network models are used to

analyze and provide early warnings for food security risks, showcasing the diverse range of food security solutions (Hou & Liang, 2022, p. 8). The World Food Summit's definition of food security, which pertains to guaranteeing consistent access to an ample supply of safe and nourishing food, underscores the need for precise and dependable indicators, particularly for susceptible groups such as farming families (Almukaddem, Alali, & Habib, 2022, p. 15). To ascertain the food security status of a country, specific indicators are employed, varying from one country to another, as there is no universal consensus on them. Among the most relied upon indicators are: (Kina. , 2013, pp. 40-41)

A. Gross Domestic Product (GDP):

Countries depend on the GDP indicator to monitor and follow the food security situation. Annual changes in GDP significantly affect food security, as a decline in GDP results in lower national income and, consequently, a decrease in overall demand, impacting the food situation.

B. Agricultural Gross Domestic Product:

This is one of the critical indicators for understanding the food situation. It serves as a measure of a country's self-reliance. The agricultural GDP is calculated in various ways, and significant changes in this output negatively affect the food situation. A decline in agricultural GDP with increased food consumption indicates a food gap that needs to be covered externally, depending on the country's financial capacity.

C. Average Individual Food Consumption:

However, this indicator only considers the overall increase or decrease in food consumption and calculates the average based on this total consumption without considering individual income. Therefore, increasing overall food consumption does not necessarily imply improving the nutritional level for all society segments. A case in point is the governmental subsidies in developing countries, which do not always reach the intended beneficiaries, and increasing the quantity at lower prices does not necessarily improve the food situation of those in need.

Other important food security indicators include average real income, average nutrition in children, local production, etc.

2.4 Risks of Food Shortage

A food shortage is a crucial problem that may have extensive consequences, especially among susceptible people. Studies have shown a correlation between food scarcity and negative consequences, such as heightened susceptibility to infectious illnesses like leprosy (Pescarini, et al., 2018); (Wagenaar, et al., 2015); (Feenstra, Nahar, Pahan, Oskam, & Richardus, 2011); (Oktaria, et al., 2018). In addition, climate change might worsen food shortages, resulting in temporary scarcity of food for certain species (Cox, Robertson, Lendvai, Everitt, & Bonier, 2019). In addition, a scarcity of food might exacerbate the already insufficient consumption of vital nutrients, thereby affecting one's general health (Wagenaar, et al., 2015). Developing countries face several risks due to

their reliance on external sources for food supply, the most significant of which are: (Mahmoud., 2021)

A. Economic Risks:

The economic risks of food shortage include the economic impacts of a disrupted balance of payments, the diversion of financial resources to food imports at the expense of importing capital and intermediate goods, damaging the process of economic development, and disturbing the local market, negatively affecting the stability of the agricultural sector.

B. Social Risks:

The social effects of food shortages are manifested in increased migration from rural to urban areas, heightened struggles of poorer population segments to obtain food, and a decline in citizens' nutritional standards.

C. Political Risks:

These risks emerge from the adverse effects of countries' dealings with food-exporting nations and their political subjugation to the will of these exporting countries.

3. Key Agricultural Reforms in Algeria

Algeria has implemented policies to enhance the agricultural sector, focusing on reforming and improving its productivity, leading to agricultural renewal. The state established various mechanisms centered around developmental programs and support funds.

3.1 The National Plan for Agricultural and Rural Development 2000-2008:

The National Plan for Agricultural Development (PNDA) is a specialized mechanism that promotes regular technical and financial management, striving to build modern, efficient agriculture through conservation, protection, and rational use of natural resources. This involves land reclamation and better exploitation of capacities. The goals of the PNDA include: (Ahnani & Laaroussi, 2018, p. 366)

- Rational and sustainable exploitation of natural resources;
- Integration into the national economy;
- Regional specialization of agricultural production;
- Restructuring of the agricultural sector and rehabilitation of natural resources nationwide;
- Improving productivity and increasing agricultural output;
- Enhancing living standards and incomes of farmers;
- Improving private initiatives in supply, distribution, and adaptation of production;
- Promoting and encouraging agricultural investment;
- Enhancing agricultural competitiveness and integrating into the global economy.

3.2 Agricultural and Rural Renewal Policy 2009-2014:

Initiated in 2008 by the Ministry of Agriculture and Rural Development, this policy focuses on achieving national consensus on food security. It is based on liberating

initiatives and energies, modernizing production facilities, and harnessing the country's vast potential. The policy aimed to increase agricultural production by providing various necessary financial resources, with approximately 1000 billion dinars (around 13.5 billion dollars) allocated for the five-year program 2009-2014 to continue previous efforts (Balour, 2018, p. 318). The goals of this policy include:

- Ensuring careful development of organization and tools in the agricultural sector to maintain production capabilities and allow for increased productivity and competitiveness, ensuring land protection and rational use of irrigation water;
- Improving food security through national agricultural production;
- Establishing a legislative framework that ensures the agricultural sector's development is economically, socially, and environmentally sustainable, promotes voluntary participation of various partners in state development efforts, and ensures social protection and rural development;
- Continuous implementation of the state's principle of adapting to plant and animal agricultural development.

3.3 Special Funds for Implementing the Agricultural and Rural Renewal:

Program In 2012, several funds were merged into a special fund for rural development under account 140-302, managed by the Director of Forestry. A unique agricultural development fund (139-302) was also established and managed by the Director of Agricultural Services (Jarfi & Rahmani, 2019, p. 270).

National Fund for Agricultural Development (FNDA): Established by Law No. 12-12 of December 26, 2012, this fund includes:

- National Fund for the Development of Agricultural Investment (FNDIA);
- Fund for the Promotion of Animal Health and Plant Protection (FPZPP);
- National Fund for the Regulation of Agricultural Production (FNRPA).

National Fund for Rural Development (FNDR): Also established by Law No. 12-12, it includes:

- Fund for Rural Development and Land Reclamation through Concession (FDRMVTTC);
- Fund for Combating Desertification and Development of Pastoral Economy and Steppes (FLDDPS);
- Special Fund for Supporting Livestock Breeders and Small Agricultural Exploiters (FSAEPEA).

3. 4 Reform of the Agricultural Sector During the Five-Year Program 2015-2018:

The axes of agricultural and rural development within the five-year program include: (Jarfi, 2019, p. 81)

Axis 1: Continuing efforts to strengthen and expand the productive base, including expanding the functional agricultural area, enhancing mechanization, promoting traditional fishing, and valuing forest and fishing agricultural products;

Axis 2: Continuing to intensify agricultural and fishing products through strategic sector development, adapting support and financing policies, rational management, and provision of the best production factors and means, along with reconditioning agricultural, rural, and fishing infrastructures, enhancing livestock feed production, developing marine and freshwater aquaculture, and valuing vegetables, fruits, and industrial crops;

Axis 3: Strengthening the protection and conservation of natural resources through sustainable management of forests and watersheds, enhancing programs for desert and steppe areas, launching extensive afforestation programs, and strengthening interventions by regional management structures;

Axis 4: Strengthening support and framing mechanisms for national production by expanding and strengthening health and plant health monitoring against pests and natural disasters, generalizing insurance in agriculture and fishing, and establishing investment support devices and productivity improvement;

Axis 5: Continuing to strengthen human capabilities and technical support through modernization of agricultural and forestry administration, training, research, guidance, and dissemination of technical progress.

4. Modeling and Testing the Co-integration Relationship between Agricultural Investment Spending and Per Capita Agricultural Output

4.1 Preliminary Tests:

The process involves a general formulation of the model, determining the stability of the series comprising the model, and finally distributing lag periods across model variables based on the Akaike Information Criterion (AIC).

A. Model Construction:

We use the Autoregressive Distributed Lag (ARDL) model, as suggested by Pesaran et al. (1997-2001). The ARDL model incorporates the temporal lag of autoregression (Lag) and allocates the explanatory variables across different periods. The model incorporates several distributed lags, with parameters that align with the number of explanatory factors. The economic variables being analyzed need a significant amount of time to affect the dependent variable, which is divided between the short-term and long-term. Therefore, the ARDL test may be used, and the research model is constructed as follows:

$$\Delta perGDP_AGR_t = \beta_0 + \sum_{i=1}^p \beta_1 \Delta perGDP_AGR_{t-i} + \sum_{t=0}^q \beta_2 \Delta INV_AGR_{t-i} + \alpha_1 perGDP_AGR_{t-1} + \alpha_2 INV_AGR_{t-1} + \varepsilon_t$$

Where:

perGDP_AGR: Per capita agricultural output (Food et al.);

INV_AGR: Public agricultural investment;

Δ : Indicates first differences;

p,q: Maximum lag periods for dependent and independent variables in the model;

β_{0-2} : Short-term relationship coefficients;

α_{1-2} : Long-term relationship coefficients.

B. Unit Root Test:

In the ARDL model, the integration order of variables should be either I(0) or I(1). Table 01 illustrates the stability and integration degree of the time series under study based on the Phillips-Perron test. It was found that the variables are integrated in the first order.

Table N°01: Stability Test of Time Series (Phillips-Perron Test)

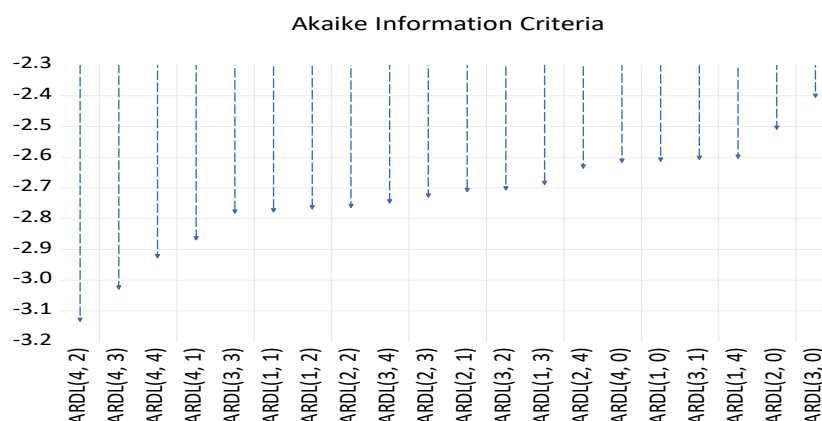
UNIT ROOT TEST RESULTS TABLE (PP)				
Null Hypothesis: the variable has a unit root				
	<u>At Level</u>			
With Constant	t-Statistic	PERGDP	INV_AGR	
		-1.9217	-2.6085	
	Prob.	0.3169	0.1063	
		n0	n0	
With Constant & Trend	t-Statistic	-0.4938	-1.8898	
	Prob.	0.9757	0.6256	
		n0	n0	
Without Constant & Trend	t-Statistic	4.5259	0.9099	
	Prob.	1.0000	0.8968	
		n0	n0	
	<u>At First Difference</u>			
		d(PERGDP)	d(INV_AGR)	
With Constant	t-Statistic	-4.6651	-4.0450	
	Prob.	0.0015	0.0057	
		***	***	
With Constant & Trend	t-Statistic	-5.1238	-5.4749	
	Prob.	0.0026	0.0013	
		***	***	
Without Constant & Trend	t-Statistic	-2.8608	-3.8278	
	Prob.	0.0065	0.0006	
		***	***	
Notes:				
a: (*)Significant at the 10%; (**)Significant at the 5%; (***) Significant at the 1% and (no) Not Significant				
b: Lag Length based on SIC				
c: Probability based on MacKinnon (1996) one-sided p-values.				
This Result is The Out-Put of Program Has Developed By:				
Dr. Imadeddin AlMosabbeh				
College of Business and Economics				
Qassim University-KSA				

Source: Prepared by the researchers based on outputs from EViews 12.

C. Selection of Optimal Lag Periods for the Model:

The process of selecting the most suitable lag periods for the model is shown in Figure 01. This figure displays the many models that may be generated by altering the lag degrees of the model's variables. This is accomplished by finding the degree (1) based on the Schwarz Information Criterion (SIC). The figure demonstrates that the ARDL (4,2) model is the most optimum since it has the lowest value based on the Akaike Information Criterion (AIC). The presented figure illustrates the lagging of the variable perGDP_AGR by four degrees and INV_AGR by two degrees in this model.

Figure N° 01: Results of the Test for Optimal Lag Periods



Source: Prepared by the researchers based on outputs from EViews 12.

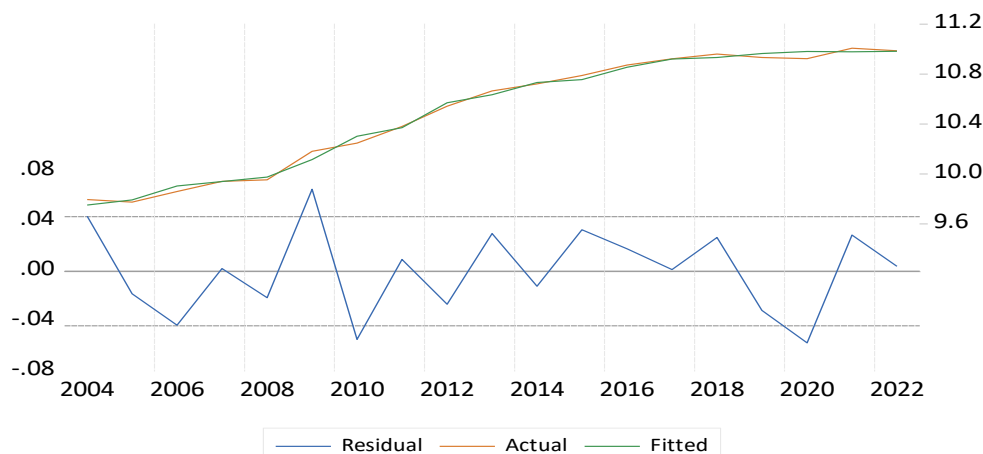
4.2 Model Quality Test (Residual Diagnostics):

Before adopting the ARDL (4,2) model for estimating short and long-term effects, it is essential to confirm the model's performance quality through the following tests:

A. Model Quality:

It is necessary to compare the actual values with those estimated by the model, as shown in the following figure:

Figure N° 02: Actual, Estimated Values, and Residuals (Model Quality)



Source: Prepared by researchers based on outputs from EViews 12.

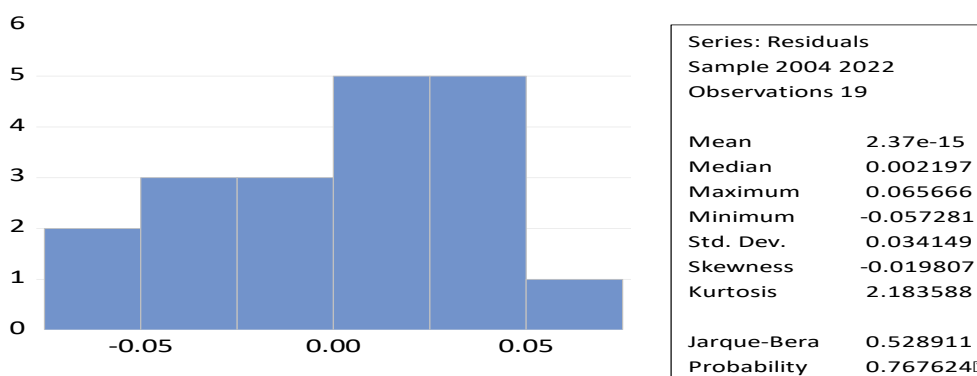
The figure indicates a close match between the estimated and actual values, suggesting good model quality. Hence, it can be relied upon for interpretation and analysis of results.

B. Normal Distribution of Residuals:

The nature of the residuals' distribution is examined through a hypothesis test stating that "residuals are normally distributed." This is observed by examining the distribution graph showing residuals clustering around the center or comparing the Jarque-Bera statistic with the Chi-Square table value. According to Figure 03, the test result is non-significant ($\alpha > 0.05$), supporting that the residuals follow a normal

distribution. With $J-B=0.76$ being less than $\chi^2=5.99$, it confirms that the model's residuals are normally distributed.

Figure N°03: Normal Distribution of Residuals.



Source: Prepared by researchers based on outputs from EViews 12.

C. Autocorrelation Test:

The absence of autocorrelation among residuals is examined by testing the hypothesis stating that "there is no autocorrelation among residuals." This is done by comparing the Lagrange statistic (R-Square) with the Chi-Square distribution value. Displayed below is a table presenting the results of the autocorrelation tests:

Table N° 02: Autocorrelation Test Results for Errors

Breusch-Godfrey Serial Correlation LM Test: Null hypothesis: No serial correlation at up to 2 lags			
F-statistic	1.249962	Prob. F(2,9)	0.3319
Obs*R-squared	4.130337	Prob. Chi-Square(2)	0.1268
Test Equation: Dependent Variable: RESID Method: ARDL Date: 08/13/23 Time: 09:11 Sample: 2004 2022 Included observations: 19 Presample missing value lagged residuals set to zero.			

Source: Prepared by researchers based on outputs from EViews 12.

Based on the LM test, the probability of the chi-square statistic is more significant than 0.05. Therefore, we accept the null hypothesis that there is no autocorrelation.

D. Homoscedasticity Test (Variance et al.):

This is assessed by comparing the calculated R-Square statistic through the Breusch-Pagan-Godfrey test with the Chi-Square distribution value. The user's text is empty. The table below displays the outcomes of the homoscedasticity test:

Table N°03: Homoscedasticity Test Results

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
Null hypothesis: Homoskedasticity			
F-statistic	0.821091	Prob. F(7,11)	0.5897
Obs*R-squared	6.520629	Prob. Chi-Square(7)	0.4804
Scaled explained SS	1.293416	Prob. Chi-Square(7)	0.9886
Test Equation:			
Dependent Variable: RESID^2			
Method: Least Squares			
Date: 08/13/23 Time: 09:19			
Sample: 2004 2022			
Included observations: 19			

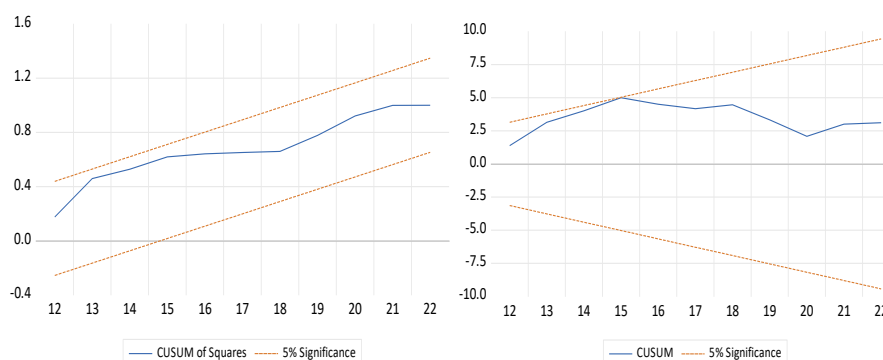
Source: Prepared by researchers based on outputs from EViews 12.

According to this test, Prob F is more significant than 0.05, indicating that F is non-significant, hence accepting the alternative hypothesis of constant variance.

D. Stability Assessment:

It is imperative to assess the stability of the model through a graphical examination of the residuals' movement and the squares of the model's residuals, as depicted in the following figure:

Figure N°04: Results of the model's stability assessment.



Source: Prepared by researchers based on the outputs of EViews 12.

Given that the graphical depiction in the CUSUM Test and CUSUM of Squares Test falls inside the critical boundaries at a significance level of 0.05, we conclude that the residuals of the model are stable.

4.3 Parameter Testing in Short and Long Terms:

A. Testing Cointegration Using the Bounds Test:

The Bounds Test approach is used to analyze the existence of common cointegration between model variables in both the long and short periods. The table below displays the results of the cointegration test conducted using the Bounds Test:

Table N°04: Cointegration Bounds Test Results

ARDL Error Correction Regression Dependent Variable: D(PERGDP_AGR) Selected Model: ARDL(4, 2) Case 2: Restricted Constant and No Trend Date: 08/13/23 Time: 10:01 Sample: 2000 2022 Included observations: 19				
ECM Regression Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(PERGDP_AGR(-1))	-0.312730	0.150019	-2.084597	0.0612
D(PERGDP_AGR(-2))	-0.137519	0.142423	-0.965566	0.3550
D(PERGDP_AGR(-3))	0.419742	0.120141	3.493746	0.0050
D(INV_AGR)	-0.000426	0.028587	-0.014897	0.9884
D(INV_AGR(-1))	-0.091423	0.037649	-2.428306	0.0335
CointEq(-1)*	-0.117774	0.024389	-4.829059	0.0005

Source: Prepared by researchers based on outputs from EViews 12.

The findings suggest that the computed F-statistic value exceeds the critical values for both the lowest and highest levels of significance. Therefore, the null hypothesis that there is no cointegration between variables is disproven, indicating the presence of a long-term equilibrium link between the individual share and agricultural investment.

B. Short-Term Parameter Analysis:

The results of estimating short-term parameters and the error correction parameter are shown in Table 05.

Table N°05: Short-term parameters and error correction parameter results

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic k	6.577382 1	10%	Asymptotic: n=1000 3.02	3.51
		5%	3.62	4.16
		2.5%	4.18	4.79
		1%	4.94	5.58
Actual Sample Size	19	10%	Finite Sample: n=35 3.223	3.757
		5%	3.957	4.53
		1%	5.763	6.48
		10%	Finite Sample: n=30 3.303	3.797
		5%	4.09	4.663
		1%	6.027	6.76

Source: Prepared by researchers based on outputs from EViews 12.

The table shows that agricultural investment does not affect the **per capita** agricultural output in the short term, which aligns with economic theory. This is because agricultural policies often manifest their effects in the long term.

The findings suggest a temporary and changing connection between agricultural investment and agricultural production per person. The presence of a statistically significant negative error correction term (CointEq(-1)=-0.1177) is responsible for this outcome. This phrase quantifies the extent to which the dependent variable's imbalance is corrected across consecutive periods. The presence of a negative sign indicates the existence of a stable and balanced connection between the variables over a lengthy period.

C. Long-Term Parameter Analysis:

The following table (Table 06) presents the results of estimating long-term parameters:

Table N° 06: Results of Long-Term Parameters

ARDL Long Run Form and Bounds Test Dependent Variable: D(PERGDP_AGR) Selected Model: ARDL(4, 2) Case 2: Restricted Constant and No Trend Date: 08/13/23 Time: 09:57 Sample: 2000 2022 Included observations: 19				
Conditional Error Correction Regression				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.685564	0.299486	2.289133	0.0428
PERGDP_AGR(-1)*	-0.117774	0.031857	-3.696981	0.0035
INV_AGR(-1)	0.116401	0.029814	3.904234	0.0025
D(PERGDP_AGR(-1))	-0.312730	0.183717	-1.702238	0.1168
D(PERGDP_AGR(-2))	-0.137519	0.171178	-0.803365	0.4388
D(PERGDP_AGR(-3))	0.419742	0.150854	2.782442	0.0178
D(INV_AGR)	-0.000426	0.036022	-0.011822	0.9908
D(INV_AGR(-1))	-0.091423	0.041194	-2.219321	0.0484
* p-value incompatible with t-Bounds distribution.				
Levels Equation Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
INV_AGR	0.988348	0.255422	3.869467	0.0026
C	5.821035	1.357222	4.288933	0.0013
EC = PERGDP_AGR - (0.9883*INV_AGR + 5.8210)				

Source: Prepared by researchers based on outputs from EViews 12.

The table demonstrates that agricultural investment significantly and positively impacts the per capita agricultural output in the long term. With every incremental unit of agricultural investment, the per capita grows by 0.98. The significance of the agricultural sector in promoting economic development and creating ample employment prospects is emphasized by the effective implementation of agricultural reforms. These changes have played a substantial role in increasing the per capita income to over 60,000 DZD in 2022.

5. CONCLUSION:

Through this study, we attempted to analyze and measure the state's efforts in promoting the agricultural sector by activating programs and public investment allocations for this sector and its contribution to increasing agricultural output growth and its impact on the per capita agricultural output from 2000 to 2022. The reforms initiated by the state and the agricultural policies pursued have reflected an increasing trend in the value of public agricultural investment. This increase has contributed to a growing percentage of labor in the agricultural sector, although it remains below the desired level, as it did not exceed 10% of the national workforce. It also contributed to increasing agricultural production, which exceeded 2,400 billion DZD. However, it only accounted for 12% of the (GDP).

The study's analysis, employing the ARDL model, indicates that while there is no immediate correlation between agricultural public investment and per capita agrarian output, a significant and enduring correlation does exist. This finding aligns with the hypothesis, especially in terms of the long-term effects of enhanced public investment in agriculture on per capita agrarian output.

The empirical research investigated the influence of agricultural production on per capita agricultural output between the years 2000 and 2022. We successfully constructed a robust economic and statistical standard model. The study's findings revealed that the Algerian agricultural sector has a beneficial although limited long-term influence on the per capita agricultural production in comparison to other nations. Despite Algeria's abundant resources that enable further investment in this crucial sector, the agricultural industry has been hindered from reaching its full potential and desired outcomes due to a lack of governmental and social determination.

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