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Agricultural Investment, Agricultural Value Added, and Economic Growth in Algeria: An ARDL Approach with Structural Breaks (1995–2024)

Nabil BEN MERZOUG[1]
Centre Universitaire d'Illizi, Illizi, Algeria, nabil.benmerzoug@cuillizi.dz
Berghouti Walid[2],
berghouti.walid@cu-tipaza.dz, University of tipaza , Algeria

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ABSTRACT

Objectives: This study assesses whether agricultural investment and agricultural value added are associated with economic growth in Algeria during 1995–2024. Prior Work: It builds on growth theory, agriculture-growth studies and evidence on resource-dependent economies. Approach: Annual data are analysed using autoregressive distributed lag bounds testing, an error-correction model, Bai-Perron structural-break analysis and robustness checks for the 2017 break and the pandemic shock. Results: The variables are integrated of order zero or one. Baseline cointegration is weak, but the 2017 break improves the specification. After accounting for the 2017 structural break, agricultural investment has a positive and statistically significant short-run effect (at the 10% level) and the bounds test supports cointegration at the 5% level; its long-run coefficient, however, is not statistically robust. The growth contribution of agricultural investment therefore operates mainly through short-run dynamics and appears conditioned by investment quality rather than expenditure volume. Implications: Policy should emphasize investment efficiency, productivity transmission and value-chain integration rather than expenditure volume. Value: The paper integrates structural breaks and shock-sensitive robustness checks into a country-specific assessment of Algeria's agriculture-growth nexus.

KEYWORDS *Agricultural Investment; Agricultural Value Added; Economic Growth; ARDL Bounds Testing; Error-Correction Model; Structural Breaks; Oil Prices; Cointegration; Algeria*

JEL CLASSIFICATION *C32; O13; Q18*

1. INTRODUCTION

Agriculture remains a strategic sector for developing and resource-dependent economies because it contributes to food security, rural employment, economic diversification, and macroeconomic resilience. In Algeria, the agricultural sector is particularly important because the national economy has historically been exposed to hydrocarbon price volatility and to fluctuations in public revenues. Although Algeria has implemented several agricultural development programs and agricultural investment has increased over time, the extent to which this investment has translated into sustained economic growth remains an open empirical

[1] Centre Universitaire d'Illizi, Illizi, Algeria, e-mail: nabil.benmerzoug@cuillizi.dz. Corresponding author.

question. From a theoretical perspective, capital accumulation contributes to output growth in the neoclassical growth framework (Solow, 1956), while endogenous growth theory emphasizes the productivity-enhancing role of public expenditure, infrastructure, and investment quality (Aschauer, 1989; Barro, 1990).

Research problem. Despite the policy priority given to agricultural development and the expansion of agricultural investment, Algeria's economic growth remains volatile and strongly exposed to external shocks. This raises the following main research question: To what extent does agricultural investment and agricultural value added affect economic growth in Algeria during 1995–2024 after controlling for oil prices, structural breaks, and exceptional shocks?

Sub-questions. The study addresses four subsidiary questions. First, are the study variables suitable for the ARDL bounds testing approach? Second, is there a long-run equilibrium relationship between economic growth, agricultural investment, agricultural value added, and oil prices? Third, does accounting for the structural break identified in 2017 improve the empirical specification? Fourth, are the results robust to the COVID-19 shock and to excluding the year 2020 from the sample?

Hypotheses. The study tests the following hypotheses: H1: Agricultural investment has a positive effect on economic growth in Algeria. H2: Agricultural value added contributes positively to economic growth. H3: Oil prices influence economic growth through short-run and/or long-run channels. H4: Structural breaks and external shocks affect the estimated relationship between agriculture-related variables and economic growth.

Importance of the study. The importance of the study lies in assessing whether agricultural investment contributes effectively to Algeria's economic diversification strategy. This issue is relevant because agriculture is expected to reduce dependence on hydrocarbons, improve food security, and strengthen non-oil growth. The study is also important from a methodological perspective because it explicitly accounts for structural change and the COVID-19 shock, two elements that can distort inference in small annual samples.

Objectives and contribution. The study aims to estimate the short-run and long-run effects of agricultural investment and agricultural value added on economic growth, examine the role of oil prices as a control variable, test for structural breaks, and evaluate the robustness of the results. Its contribution lies in combining the ARDL-ECM framework with Bai-Perron structural break testing and robustness checks based on a post-2017 dummy, a COVID-19 dummy, and a sample excluding 2020. The study adopts a cautious interpretation of the results because the sample is small and the long-run coefficients of the main agricultural variables are not consistently significant.

This study does not assume that higher agricultural investment automatically leads to higher economic growth. Rather, it examines whether the observed increase in agricultural investment has translated into measurable short-run or long-run macroeconomic effects. This distinction is important in the Algerian context, where public investment may be influenced by hydrocarbon revenue cycles and where even real investment outlays may not necessarily translate into productivity-enhancing capital accumulation. Accordingly, the study adopts a cautious empirical interpretation and treats the ARDL estimates as evidence on statistical association and dynamic adjustment rather than definitive proof of causal transformation.

2. THEORETICAL FRAMEWORK AND LITERATURE REVIEW

2.1 Agricultural Investment And Economic Growth

Agricultural investment can affect economic growth through several channels. It expands productive capacity through land development, irrigation, mechanization, storage, rural roads, and modern inputs. It can also increase agricultural productivity, reduce post-harvest losses, strengthen food supply, and stimulate demand for upstream and downstream activities. However, the growth effect of investment depends not only on the amount invested but also on the efficiency of allocation, the quality of projects, the absorptive capacity of farmers, and the degree of integration between agriculture, agro-processing, and markets (World Bank, 2007). This explains why a rise in investment may fail to generate a statistically significant long-run growth effect when investment is poorly targeted or when complementary infrastructure is weak.

Recent empirical literature further indicates that agricultural investment is most effective when it is embedded in complementary systems of technology, finance, infrastructure, and extension services. Evidence from rural economies shows that agricultural investment can stimulate sustainable rural growth, while fiscal and financial support can raise agricultural total factor productivity when combined with technological progress and labor-market improvements (Yang et al., 2025; Ma & Li, 2025). Public investment programs can also improve agricultural productivity, although effects differ across regions and depend on local conditions (Zhang et al., 2025).

2.2 Agricultural Value Added And Structural Transformation

Agricultural value added measures the productive contribution of agriculture to the economy. It can support growth through income generation, employment, food security, domestic demand, and linkages with agro-industry. Timmer (2002) argues that agriculture contributes to development when it supports structural transformation and productivity growth. Tiffin and Irz (2006) and Awokuse and Xie (2015) show that agriculture may matter for growth in developing economies, but the magnitude and direction of the relationship vary across countries and depend on productivity, market integration, and institutional conditions. For Algeria, agricultural value added may not automatically generate aggregate growth if the sector remains vulnerable to climate variability, water scarcity, low productivity, and weak agro-industrial linkages.

Recent studies on structural transformation emphasize that agricultural value added supports development more effectively when productivity growth is linked to labor reallocation, agro-processing, logistics, and non-farm employment opportunities. This view is consistent with Gollin (2023a), Gollin and Kaboski (2023b), Lagakos (2023), and related recent work arguing that agriculture contributes to growth not merely through its output share but through its capacity to trigger broader structural change.

2.3 Oil Prices And Growth In Resource-Dependent Economies

In hydrocarbon-exporting economies, oil prices affect growth through fiscal revenues, public investment, imports, exchange-rate pressures, and macroeconomic stability. The resource-curse literature suggests that natural resource dependence can increase volatility and weaken non-hydrocarbon sectors if oil revenues are not transformed into productive investment (Frankel, 2010; Sachs & Warner, 1995). Empirical studies on oil-exporting economies show that oil-price

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shocks may have asymmetric and delayed effects on output (Farzanegan & Markwardt, 2009; Mehrara, 2008; Rautava, 2004). Oil prices are therefore included in this study as a control variable because agricultural investment in Algeria may partly depend on fiscal space generated by hydrocarbon revenues (Bank of Algeria, 2024).

2.4 Previous Empirical Studies And Research Gap

The empirical literature provides mixed evidence on the agriculture-growth relationship. Tiffin and Irz (2006) examine whether agriculture acts as an engine of growth and find that the relationship is not uniform across countries. Awokuse and Xie (2015) find that agriculture can contribute to growth in developing countries, but the effect depends on structural and country-specific conditions. Jatuporn et al. (2011), using time-series methods for Thailand, provide evidence of a long-run relationship between agriculture and economic growth, while emphasizing the importance of dynamic modeling. More recent sectoral and ARDL-based studies also show that agricultural activity may influence macroeconomic outcomes, but results are sensitive to model specification, structural changes, and the quality of sectoral data.

For Algeria and other resource-dependent economies, the relationship between agriculture and growth must be interpreted in the context of hydrocarbon dependence and the policy objective of economic diversification. Country-specific assessments provide useful support for this interpretation. IMF (2024) emphasizes Algeria's exposure to hydrocarbon revenue volatility and the importance of fiscal adjustment and diversification. World Bank (2024) highlights the need to strengthen resilience, improve investment efficiency, and support non-hydrocarbon productivity. African Development Bank (2024) similarly stresses that Algeria's transformation strategy depends on improving the quality of public investment and reducing dependence on hydrocarbon cycles, while FAO (2022) underlines the importance of water management, productivity, and value-chain upgrading in the agricultural sector. These studies are consistent with the empirical logic of this paper: agricultural investment can contribute to growth only if it is transformed into productivity gains, irrigation capacity, logistics, agro-processing, and stronger value-chain integration. In this context, the expected positive effect of agricultural investment may fail to appear in the long run if investment does not translate into productivity gains, if irrigation and infrastructure constraints persist, or if agricultural value chains remain weakly integrated with the rest of the economy.

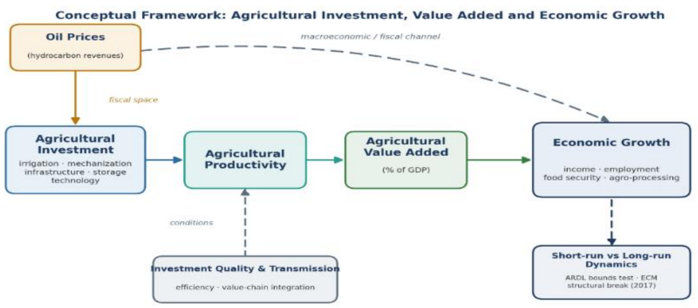

Figure 1. Conceptual framework of the agriculture–growth nexus in Algeria
Source: Author's own elaboration.

The conceptual framework of the study assumes that agricultural investment contributes to agricultural productivity through improvements in irrigation systems, mechanization, rural infrastructure, storage facilities, and technological adoption. Higher agricultural productivity is expected to increase agricultural value added, which subsequently contributes to economic growth through income generation, employment creation, food security enhancement, and stronger linkages with agro-processing industries. In resource-dependent economies such as Algeria, oil prices influence both agricultural investment capacity and overall economic growth through their impact on fiscal revenues and public expenditure.

2.5 Research Gap

Despite the growing body of literature examining the relationship between agriculture and economic growth, several important gaps remain. First, few studies have simultaneously incorporated agricultural investment, agricultural value added, oil prices, structural breaks, and ARDL-ECM modelling within a unified analytical framework, particularly in the context of Algeria. Second, existing studies often overlook the role of structural shifts associated with the post-2017 macroeconomic adjustment period and the unprecedented disruption caused by the COVID-19 pandemic. Third, limited attention has been paid to how agricultural investment operates within resource-dependent economies where investment dynamics are strongly influenced by hydrocarbon revenues. Finally, the interaction between agricultural investment, productivity transmission mechanisms, and long-run economic growth remains insufficiently explored in North African economies. Accordingly, this study attempts to fill these gaps by integrating agricultural investment, agricultural value added, oil prices, structural-break analysis, and robustness testing within an ARDL-ECM framework covering Algeria during 1995–2024.

Recent studies reinforce the relevance of this gap. Agricultural investment and financial support have been shown to matter for rural growth and agricultural total factor productivity, but their effects vary according to regional conditions, technology adoption, institutional support, and investment quality (Yang et al., 2025; Ma & Li, 2025; Zhang et al., 2025). Dynamic ARDL evidence also indicates that agricultural inputs such as irrigation, fertilizer, and mechanization affect agricultural economic growth differently in the short and long run (Abate et al., 2025). Similarly, recent work on structural transformation emphasizes that agricultural productivity contributes to growth when it strengthens labor reallocation, market linkages, and non-farm development rather than remaining isolated from the wider economy (Gollin & Kaboski, 2023b; Lagakos, 2023).

3. DATA AND METHODOLOGY

3.1 Data And Variables

The study uses annual data for Algeria over 1995–2024. The dependent variable is economic growth (ECO), measured as the annual GDP growth rate in percent. The explanatory variables are agricultural investment (AGRINV), measured as real public/sectoral agricultural investment expenditure in billion constant Algerian dinars, agricultural value added (AgriVA), measured as agriculture, forestry, and fishing value added as a percentage of GDP, and oil prices (OILPR), measured as the annual average crude oil price in U.S. dollars per barrel. Since economic growth includes a negative value in 2020, ECO is kept in level form, while AGRINV, AgriVA, and OILPR are transformed into natural logarithms and denoted lnAGRINV, lnAgriVA, and lnOILPR in the econometric specification.

Table 1. Definition, Measurement, and Data Sources of Study Variables

Variable	Symbol	Measurement	Expected Sign	Source / Note
Economic Growth	ECO	Annual GDP growth rate (%)	Dependent variable	World Bank WDI, indicator NY.GDP.MKTP.KD.ZG
Agricultural Investment	AGRINV	Real public/sectoral agricultural investment expenditure, billion constant DZD	+	MADR agricultural statistics; ONS statistical yearbooks; author-harmonized series
Agricultural Value Added	AgriVA	Agriculture, forestry, and fishing value added (% of GDP)	+	World Bank WDI, indicator NV.AGR.TOTL.ZS
Oil Price	OILPR	Annual average crude oil price, USD/barrel	+/-	World Bank Commodity Markets Pink Sheet; annual average crude oil price

Source: Author's compilation based on World Bank World Development Indicators (WDI) (World Bank, 2025a), the World Bank Commodity Markets Pink Sheet (World Bank, 2025b), Ministry of Agriculture and Rural Development (MADR) agricultural statistics, and Office National des Statistiques (ONS) statistical yearbooks; calculations performed in R.

The measurement choices are consistent with the empirical specification: ECO is not log-transformed because it includes a negative observation in 2020, whereas AGRINV, AgriVA, and OILPR are expressed in logarithmic form to reduce scale effects and allow semi-elasticity interpretation. In the econometric model, the transformed variables are denoted lnAGRINV, lnAgriVA, and lnOILPR.

Construction of AGRINV. AGRINV is constructed as an author-harmonized annual series from MADR agricultural statistics and ONS statistical yearbooks. It is treated as real public/sectoral agricultural investment expenditure in billion constant Algerian dinars, deflated to remove the effect of price changes. When both sources overlap, the MADR sectoral value is retained as the primary reference and ONS is used for consistency checking; when a single source is available, the reported observation is retained after verifying the unit and price basis. Because the series is expressed in real (deflated) terms, it more closely approximates real agricultural capital expenditure than a nominal series would. For full replication, a data appendix should report, for each year, the source edition, table number, unit, the deflator and base year used, whether the observation refers to budgeted or executed expenditure, and any harmonization decision.

Real-term measurement. Because AGRINV is expressed in real (constant-price) dinars, the series is purged of inflation and general price-level changes, so that its movements reflect changes in real investment effort rather than nominal price effects. Expressing investment in real terms strengthens the interpretation of AGRINV as a proxy for real agricultural capital expenditure rather than a purely nominal magnitude. The estimated coefficients should nonetheless be read with the caution usually attached to long historical series, since the results may remain sensitive to the choice of deflator and base year. Accordingly, the absence of a statistically significant long-run AGRINV coefficient is better attributed to allocative efficiency and transmission factors than to a nominal-measurement artefact. Future robustness checks could test alternative deflators and base years, as well as AGRINV/GDP and AGRINV/public expenditure ratios.

Caveat on AgriVA measurement. AgriVA is measured as agriculture, forestry and fishing value added as a percentage of GDP. This indicator captures the relative contribution of agriculture to aggregate output, but it does not necessarily measure real agricultural production or productivity. A rise in AgriVA as a share of GDP may reflect improved agricultural performance, but it may also reflect slower growth or contraction in other sectors. Consequently, the estimated coefficient of lnAgriVA should be interpreted as evidence on the agricultural share in GDP rather than as evidence on real agricultural productivity. Future studies should test real agricultural value added, agricultural value-added growth or agricultural productivity indicators.

3.2 Econometric Specification

The baseline long-run relationship between economic growth and its determinants is specified as in Equation (1):

$$ECO_t = \beta_0 + \beta_1\, lnAGRINV_t + \beta_2\, lnAgriVA_t + \beta_3\, lnOILPR_t + \varepsilon_t \tag{1}$$

The unrestricted ARDL(p, q_1, q_2, q_3) representation is given by Equation (2):

$$ECO_t = \alpha_0 + \sum_{i=1}^{p} \varphi_i\, ECO_{t-i} + \sum_{j=0}^{q_1} \theta_{1j}\, lnAGRINV_{t-j} + \sum_{j=0}^{q_2} \theta_{2j}\, lnAgriVA_{t-j} + \sum_{j=0}^{q_3} \theta_{3j}\, lnOILPR_{t-j} + u_t \tag{2}$$

The corresponding error-correction model (ECM) is specified as in Equation (3):

$$\Delta ECO_t = c_0 + \sum_{i=1}^{p} \gamma_i\, \Delta ECO_{t-i} + \sum_{j=0}^{q_1} \delta_{1j}\, \Delta lnAGRINV_{t-j} + \sum_{j=0}^{q_2} \delta_{2j}\, \Delta lnAgriVA_{t-j} + \sum_{j=0}^{q_3} \delta_{3j}\, \Delta lnOILPR_{t-j} + \lambda_1\, ECT_{t-1} + e_t \tag{3}$$

where ECTt−1 is the lagged long-run equilibrium error and λ_1 is expected to be negative. The maximum lag length is restricted to two in the preferred R-based specification because the sample contains only 30 annual observations and higher lag orders would sharply reduce the degrees of freedom. Optimal lags are selected using the Akaike Information Criterion (AIC).

All unit-root tests, bounds tests, error-correction estimation, and Bai–Perron structural-break analysis are implemented in the R statistical computing environment to ensure full reproducibility. Since ECO is measured in percentage points while the regressors are in logarithms, the coefficients are interpreted as semi-elasticities: a 1% increase in a logged regressor is associated approximately with a $\beta/100$ percentage-point change in ECO, holding other factors constant.

3.3 Estimation Strategy

The empirical procedure follows six steps: descriptive statistics and correlation analysis; unit root tests using ADF (Dickey & Fuller, 1979), Phillips-Perron (Phillips & Perron, 1988), and KPSS (Kwiatkowski et al., 1992); baseline ARDL estimation and bounds testing (Pesaran & Shin, 1999; Pesaran et al., 2001); diagnostic and stability tests; Bai-Perron structural-break analysis (Bai & Perron, 2003); and robustness checks using D2017, D2020, and exclusion of 2020. The R-based ARDL model adjusted for the 2017 structural break is retained as the preferred specification because it is more parsimonious and better suited to the small annual sample. EViews outputs are used only as diagnostic and robustness evidence, not as a direct substitute for the preferred R specification, because the EViews sensitivity model uses a different and higher-order lag structure.

Small-sample inference. The sample covers 30 annual observations only. ARDL is relatively suitable for small samples compared with some alternative cointegration methods, but the inclusion of lagged variables, controls, and structural-break dummies reduces the available degrees of freedom. Therefore, marginally significant coefficients are interpreted cautiously and are not treated as strong evidence. Given the sample of only 30 observations, the bounds-test outcomes reported below are interpreted with reference to the small-sample critical values of Narayan (2005) rather than relying solely on the asymptotic critical values of Pesaran et al. (2001). Robust, Newey-West, or bootstrap-based standard errors were not used as the main estimator in the reported tables; they are recommended as complementary checks in future replications, and the related scripts can be provided as supplementary material.

4. EMPIRICAL RESULTS AND DISCUSSION

4.1 Descriptive Statistics And Correlation Analysis

Table 2. Descriptive Statistics of the Study Variables, 1995–2024

Variable	Symbol	Mean	Median	Std. Dev.	Minimum	Maximum
Economic Growth	ECO	3.140	3.400	2.086	-5.000	6.500
Agricultural Investment	AGRINV	209.821	206.525	163.237	23.200	664.670
Agricultural Value Added	AgriVA	12.662	12.260	2.646	7.800	18.450
Oil Price	OILPR	57.082	56.685	30.866	12.280	109.450

Source: Author's calculations based on R outputs.

The descriptive statistics indicate moderate fluctuations in economic growth and substantial variability in agricultural investment and oil prices. Agricultural value added appears more stable than investment, suggesting that increases in investment do not automatically translate into proportional value-added gains.

Table 3. Correlation Matrix of the Study Variables

Variables	ECO	AGRINV	AgriVA	OILPR
ECO	1.0000	-0.1173	-0.3587	-0.1310
AGRINV	-0.1173	1.0000	0.0917	0.6507
AgriVA	-0.3587	0.0917	1.0000	-0.1612
OILPR	-0.1310	0.6507	-0.1612	1.0000

Source: Author's calculations based on R outputs.

The correlation matrix based on the variables in levels shows weak negative correlations between economic growth and both agricultural investment and oil prices. The strongest level-based correlation is observed between agricultural investment and oil prices (about 0.65), suggesting possible links between hydrocarbon revenues and investment capacity. This should not be confused with the stronger log-transformed correlation reported in the heatmap, where the association between lnAGRINV and lnOILPR reaches about 0.86. The difference reflects the transformation and scale treatment, not a contradiction. In both cases, correlation analysis remains preliminary and cannot capture dynamic or long-run relationships.

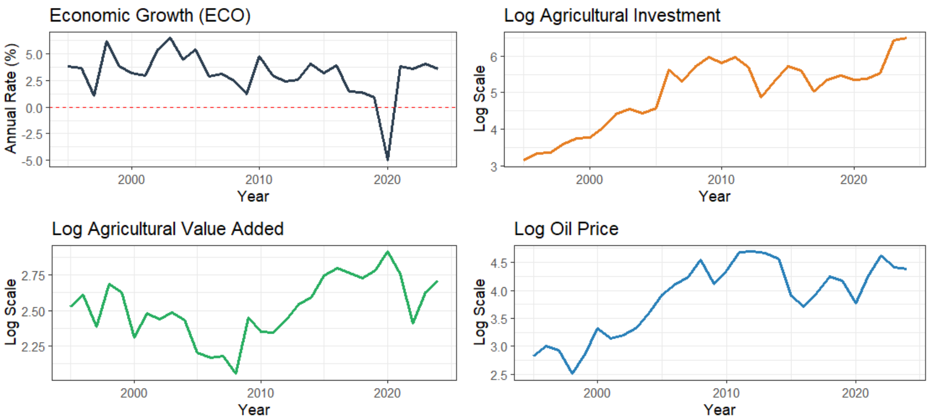

Figure 2. Time-series evolution of the study variables, 1995–2024

Source: Author's own elaboration based on R outputs.

Figure 2 shows the time evolution of the variables. Economic growth fluctuates considerably and records a sharp contraction in 2020. Agricultural investment follows an upward pattern, while oil prices exhibit clear volatility. These patterns support the use of a dynamic econometric framework.

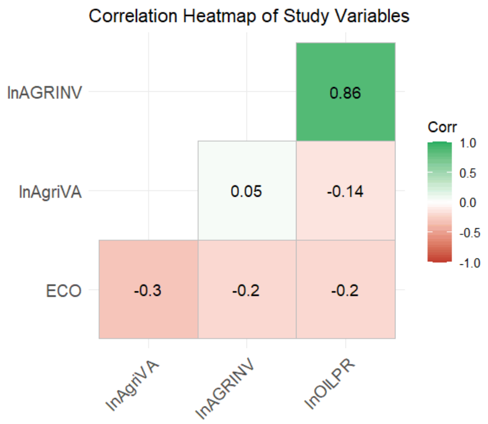

Figure 3. Correlation heatmap of log-transformed study variables

Source: Author's own elaboration based on R outputs.

Figure 3 is based on log-transformed variables. It confirms the stronger positive association between lnAGRINV and lnOILPR, while the associations between ECO and the explanatory variables remain weak to moderate. The figure is used only as exploratory evidence and should not be interpreted as causality.

4.2 Unit Root Tests

Table 4. Unit Root Test Results (ADF, Phillips-Perron, KPSS)

Variable	Form	ADF (constant)	ADF (const.+trend)	PP (constant)	KPSS (constant)	Integration order
ECO	Level	-2.295	-3.182*	-4.155***	0.347	I(0)
	Δ	-3.501***	—	-9.588***	0.057	
lnAGRINV	Level	-1.414	-2.086	-0.539	0.856***	I(1)
	Δ	-5.733***	—	-4.632***	0.128	
lnAgriVA	Level	-2.082	-2.519	0.556	0.431*	I(1) (borderline)
	Δ	-6.657***	—	-1.965	0.120	
lnOILPR	Level	-1.658	-1.841	-1.114	0.749***	I(1)
	Δ	-5.279***	—	-2.835*	0.131	

*Notes: Entries are test statistics. ADF augmentation lags selected by AIC (max = 4); KPSS long-run variance uses a Bartlett kernel with automatic bandwidth. ADF and PP test H0: a unit root (series non-stationary); KPSS tests H0: stationarity. First-difference tests use a constant only. ***, **, * denote rejection of the respective null at the 1%, 5%, and 10% levels. ADF/PP critical values (constant): -3.43, -2.86, -2.57; (constant+trend): -3.96, -3.41, -3.12. KPSS critical values (constant): 0.739, 0.463, 0.347. The series combine I(0) and I(1) orders with no I(2), validating the ARDL bounds approach.*

Source: Author's calculations based on R outputs.

The combined ADF, PP, and KPSS tests show that the variables are a mixture of I(0) and I(1). Although the evidence for lnAgriVA is mixed, no variable is found to be integrated of order two. This validates the use of the ARDL bounds-testing approach. All unit-root tests are estimated with an intercept and, for the variables in levels, additionally with an intercept and a linear trend; the ADF lag length is selected automatically using the AIC, and the PP and KPSS tests use the Bartlett-kernel automatic bandwidth. The full test statistics, their p-values, and the deterministic specification for each variable are reported in Table 4. Because AgriVA is measured as a share of GDP, its stationarity and interpretation may be affected by changes in other sectors. Future robustness checks should test real agricultural value added, agricultural value-added growth, or agricultural productivity indicators if consistent data become available.

4.3 Baseline ARDL Results

Table 5. Optimal Lag Selection for the Baseline ARDL Model Based on AIC

Rank	ECO	lnAGRINV	lnAgriVA	lnOILPR	AIC
1	1	0	2	2	129.1431
2	2	2	2	2	130.4293
3	1	0	2	1	132.4959
4	1	0	1	1	133.7768
5	1	1	1	1	135.3766

Source: Author's calculations based on R outputs.

The AIC selects ARDL(1,0,2,2) as the baseline model when the maximum lag length is restricted to two. This restriction is appropriate for the small annual sample because excessive lags reduce degrees of freedom and may lead to over-parameterization. The detailed lag-ranking table is retained to ensure transparency, while the preferred interpretation relies on the more parsimonious and structural-break-adjusted specification.

Table 6. Baseline ARDL(1,0,2,2) Estimation Results

Variable	Coefficient	Std. Error	t-statistic	p-value
Intercept	14.6833	7.1420	2.056	0.0538
ECO(-1)	0.1802	0.2150	0.838	0.4125
lnAGRINV	-0.5245	1.1359	-0.462	0.6495
lnAgriVA	-2.2250	4.7082	-0.473	0.6419
lnAgriVA(-1)	-8.8857	5.2933	-1.679	0.1096
lnAgriVA(-2)	6.9551	4.7207	1.473	0.1570
lnOILPR	2.3199	2.4780	0.936	0.3609
lnOILPR(-1)	-8.0265	3.3595	-2.389	0.0274
lnOILPR(-2)	6.0213	3.0096	2.001	0.0599

Source: Author's calculations based on R outputs.

The baseline ARDL coefficients indicate that most variables are not statistically significant at the 5% level. Agricultural investment is negative and statistically insignificant, while oil price lags are more relevant in the short-run dynamics.

Table 7. Baseline Cointegration, ECM, and Long-run Effects

Item	Coefficient / Statistic	Std. Error	p-value	Interpretation
Bounds F-statistic	4.2907	-	0.0543	Cointegration at 10% only
ECT(-1)	-0.8198	0.1839	0.0002	81.98% adjustment
LR lnAGRINV	-0.6397	1.4339	0.6605	Not significant
LR lnAgriVA	-5.0688	2.8669	0.0931	Weakly significant at 10%
LR lnOILPR	0.3838	2.0985	0.8568	Not significant

Source: Author's calculations based on R outputs.

The baseline bounds test provides only borderline evidence of cointegration at the 10% level. However, the error correction term is negative and highly significant, suggesting an adjustment mechanism toward long-run equilibrium. Long-run coefficients do not provide strong evidence of a direct positive effect of agricultural investment on economic growth. Given the small sample, this result should be read alongside Narayan-type small-sample bounds rather than relying only on asymptotic critical values; accordingly, the baseline specification is treated as preliminary rather than definitive.

4.4 Diagnostic And Stability Tests

Table 8. Diagnostic Test Results for the Preferred Error-Correction Model (ARDL(1,2,0,1,1) with D2017)

Test	Statistic	p-value	Decision
Breusch-Godfrey serial correlation LM (1 lag)	LM = 0.6435	0.4225	No serial correlation
Breusch-Pagan-Godfrey heteroskedasticity	LM = 9.0555	0.4322	No heteroskedasticity
Jarque-Bera normality	JB = 2.0044	0.3671	Residual normality not rejected
Ramsey RESET (one fitted power)	F(1,17) = 0.8186	0.3782	No functional-form misspecification
VIF: lnAGRINV	4.327	—	No severe multicollinearity

VIF: lnAgriVA	1.147	—	No severe multicollinearity
VIF: lnOILPR	4.406	—	No severe multicollinearity

Source: Author's synthesis based on EViews diagnostic outputs and auxiliary R multicollinearity checks.

The diagnostic evidence for the preferred error-correction specification confirms the statistical adequacy of the model. The Breusch-Godfrey LM test (LM = 0.64, p approximately 0.42) indicates no serial correlation; the Breusch-Pagan-Godfrey test (LM = 9.06, p approximately 0.43) shows no heteroskedasticity; the Jarque-Bera test (JB = 2.00, p approximately 0.37) does not reject residual normality; and the Ramsey RESET test (F = 0.82, p approximately 0.38) reveals no functional-form misspecification. The auxiliary variance-inflation factors remain well below conventional thresholds, indicating the absence of severe multicollinearity among the main regressors. All estimation, inference, and structural-break analysis are conducted in R on the annual 1995-2024 dataset.

Diagnostic interpretation. Although one R-based specification rejected residual normality, the EViews robustness diagnostics suggest that this problem is not robust across alternative estimations. Given the small annual sample and the sensitivity of Algerian macroeconomic data to crisis years, the diagnostic evidence should still be interpreted cautiously. Nevertheless, the EViews results strengthen confidence in the overall reliability of the empirical framework and support the use of standard inference as a reasonable approximation, while maintaining conservative interpretation of marginally significant coefficients.

Table 9. Stability Test Results

Test	**Statistic**	**p-value**	**Decision**
Recursive CUSUM	0.8765	0.0835	Stable at 5%; marginal at 10%
OLS-CUSUM	0.4858	0.9723	Stable

Source: Author's calculations based on R outputs.

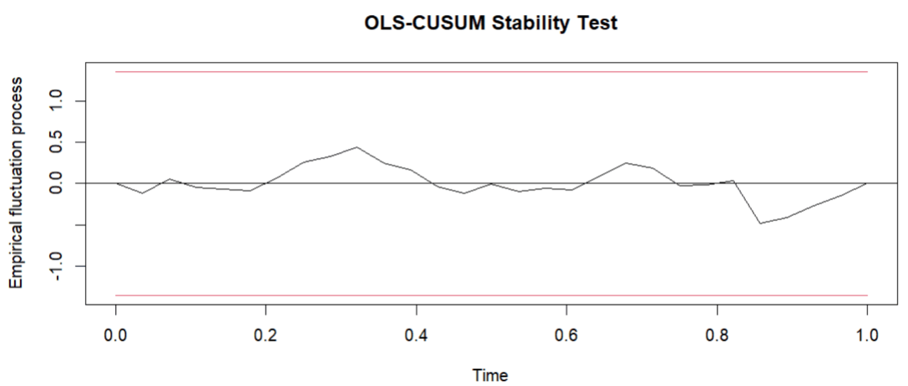

Figure 4. OLS-CUSUM stability test

Source: Author's own elaboration based on R outputs.

Figure 4 shows that the OLS-CUSUM path remains within the critical bounds. This supports parameter stability and reinforces the reliability of the estimated baseline ARDL model.

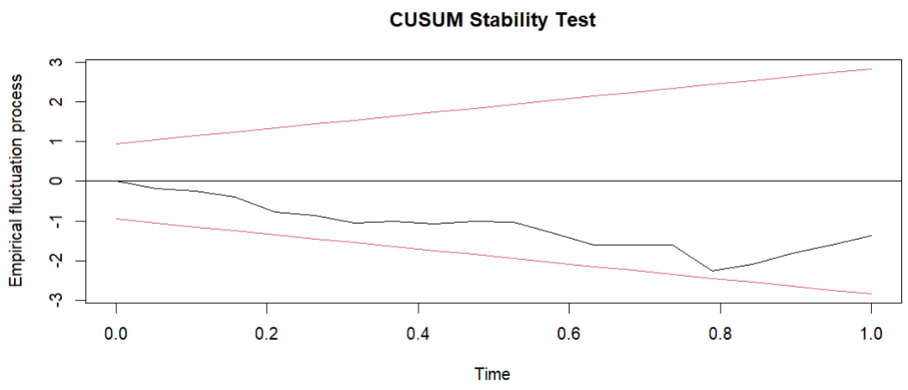

Figure 5. Recursive CUSUM stability test

Source: Author's own elaboration based on R outputs.

Figure 5 also indicates that the recursive CUSUM path remains within the 5% critical bounds, although the test is marginal at the 10% level. Overall, the stability evidence is acceptable.

4.5 Structural Break Analysis And Improved ARDL Model

Table 10. Bai-Perron Structural Break Test Results

Number of Breaks	Break Year(s)	RSS	BIC
0	-	107.17	140.34
1	2017	42.90	129.88
2	2005, 2017	24.96	130.63
3	2001, 2009, 2017	16.37	135.00

Source: Author's calculations based on R outputs.

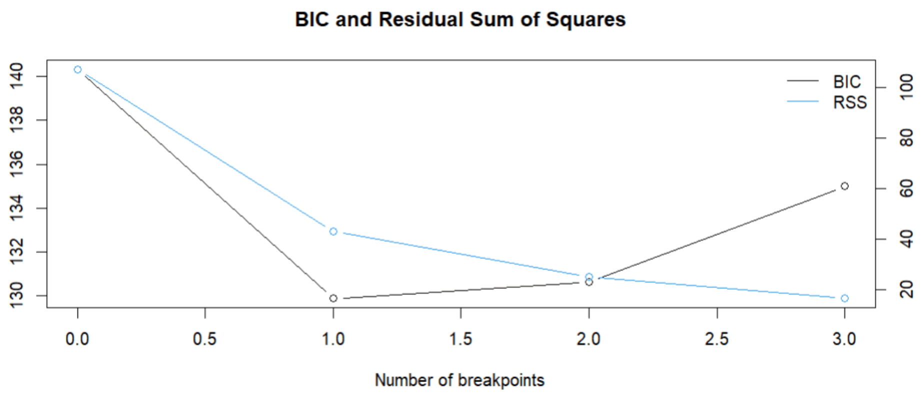

Figure 6. BIC and residual sum of squares for structural break selection

Source: Author's own elaboration based on R outputs.

The Bai-Perron test identifies 2017 as the preferred structural break year according to BIC. Therefore, the ARDL model is re-estimated with a post-2017 dummy, and this specification is treated as the preferred structural-break-adjusted model. Economically, the 2017 break can be linked to the delayed effects of the 2014-2016 oil-price decline, the tightening and reorientation

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of public spending, fiscal adjustment pressures, import-management measures, and changes in the financing of public investment. These developments may have altered the transmission channel from oil revenues to sectoral expenditure and from agricultural investment to aggregate growth.

Table 11. Lag Selection for ARDL with D2017

Rank	ECO	lnAGRINV	lnAgriVA	lnOILPR	D2017	AIC
1	1	2	0	1	1	130.3921
2	1	2	0	2	1	131.9189
3	1	2	1	1	1	131.9323
4	1	1	1	1	1	134.6519

Source: Author's calculations based on R outputs.

The AIC selects ARDL(1,2,0,1,1) after including the post-2017 dummy. This confirms that accounting for structural change changes the dynamic specification of the model.

Table 12. Bounds Test and ECM with D2017

Item	Coefficient / Statistic	Std. Error	p-value	Interpretation
Bounds F-statistic	4.7992	-	0.0147	Cointegration at 5%
d(lnAGRINV)	2.1607	1.1360	0.0703	Positive; significant at 10%
d(lnAGRINV(-1))	1.9216	1.1143	0.0986	Positive; significant at 10%
d(lnOILPR)	5.2160	1.4572	0.0017	Positive; significant at 1%
d(D2017)	-2.2332	2.1020	0.2996	Not significant
ECT(-1)	-1.0814	0.1997	0.0000	Rapid adjustment; possible overshooting

Source: Author's calculations based on R outputs.

After incorporating D2017, the bounds test becomes statistically significant at the 5% level, and the error correction term remains negative and highly significant. The R-based results also show that agricultural investment becomes positive and weakly significant in the short run after controlling for the 2017 structural break. This suggests that agricultural investment may contribute temporarily to economic activity when structural change is explicitly considered. However, the long-run coefficient remains statistically insignificant, indicating that the results do not provide strong evidence of a stable positive long-run effect of agricultural investment on economic growth.

Interpretation of ECT overshooting. The estimated error correction coefficient of approximately -1.08 indicates a rapid adjustment process toward long-run equilibrium. Since its absolute value is slightly greater than unity, the adjustment may involve overshooting: deviations from long-run equilibrium are corrected by more than their initial size within one year before the system gradually returns toward its equilibrium path. Economically, this is plausible in the Algerian context, where growth is exposed to abrupt oil-price shocks, fiscal adjustments, and public-expenditure cycles. Nevertheless, the magnitude may also reflect model sensitivity caused by the small sample, the inclusion of a structural-break dummy, and the annual frequency of the data. Therefore, the coefficient should be interpreted as evidence of fast but potentially volatile adjustment, not as proof of a perfectly stable convergence mechanism. In small annual samples such as this one (n = 30), an error-correction coefficient whose absolute value exceeds unity is frequently a symptom of estimation imprecision rather than a genuine structural feature; the value is therefore reported for transparency and is not used to support any strong claim about the speed of convergence.

Table 13. Long-run Coefficients with D2017

Variable	Coefficient	Std. Error	t-statistic	p-value	Decision
lnAGRINV	-0.6117	1.7011	-0.3596	0.7233	Not significant
lnAgriVA	4.4057	3.8841	1.1343	0.2716	Not significant
lnOILPR	1.0419	2.5038	0.4161	0.6822	Not significant
D2017	-3.3773	1.4863	-2.2723	0.0356	Significant at 5%

Source: Author's calculations based on R outputs.

The long-run coefficients with D2017 show that agricultural investment, agricultural value added, and oil prices remain statistically insignificant in the long run. The structural break dummy is negative and significant, suggesting a downward shift in growth dynamics after 2017. Thus, the evidence supports short-run relevance rather than a strong long-run impact of agricultural investment.

4.6 Robustness Checks

Table 14. Summary of Robustness Checks

Model	Selected ARDL	AIC	Bounds p-value	ECT	ECT p-value	Main conclusion
Baseline	ARDL(1,0,2,2)	129.1431	0.0543	-0.8198	0.0002	Borderline cointegration at 10%

Model	Selected ARDL	AIC	Bounds p-value	ECT	ECT p-value	Main conclusion
With D2017	ARDL(1,2,0,1,1)	130.3921	0.0147	-1.0814	0.0000	Cointegration improves after break
With D2020	ARDL(1,0,0,2,1)	111.2897	0.1778	-0.8785	0.0003	COVID shock significant; no cointegration
Excluding 2020	ARDL(1,0,0,2)	104.8942	0.0354	-0.9356	0.0001	Cointegration at 5% after removing shock

Source: Author's calculations based on R outputs.

Figure 7. Robustness check comparison

Source: Author's own elaboration based on R outputs.

The robustness checks clarify the role of each specification. The D2017 model supports cointegration at the 5% level and is retained as the preferred structural-break-adjusted model. The D2020 model captures the temporary negative COVID-19 shock but does not support cointegration. Excluding 2020 restores cointegration at the 5% level, confirming that the pandemic year affected the baseline estimates.

4.7 Economic Discussion

The empirical evidence yields a clear and policy-relevant pattern: once the 2017 structural break is incorporated, agricultural investment exerts a positive and statistically significant short-run effect on economic growth (significant at the 10% level), and the bounds test supports a long-run relationship at the 5% level, whereas the long-run coefficient of agricultural investment itself is not statistically robust. This finding should not be interpreted as evidence that agricultural investment is economically irrelevant. Rather, it suggests that the volume of agricultural spending alone has not been sufficient to generate a stable and measurable contribution to long-run growth. One possible explanation is the pro-cyclical nature of public investment in a rent-dependent economy. The strong association between agricultural investment and oil prices, which reaches approximately 0.86 in the log-transformed specification and about 0.65 in the level-based correlation matrix, suggests that agricultural spending may partly follow hydrocarbon revenue cycles rather than an autonomous productivity-oriented investment strategy. When oil prices rise, fiscal space may expand and public investment can increase; when oil prices fall, investment capacity may become constrained.

This rent-dependent pattern may help explain why agricultural investment does not show a statistically significant long-run effect. If investment expands mainly during periods of oil-revenue abundance, it may reflect fiscal availability more than productivity-enhancing transformation. The weak long-run significance of agricultural investment may therefore reflect limited allocative efficiency rather than the absence of investment effort. However, the model does not directly measure irrigation, mechanization, storage, logistics, or value-chain integration. Consequently, the policy implications should be read as suggestive rather than causal: the results point to the need to examine whether agricultural spending is efficiently allocated and whether it is transformed into productivity gains, not simply to increase nominal investment volumes.

The findings are broadly consistent with recent evidence from developing and resource-dependent economies. Recent studies suggest that agricultural investment contributes to economic growth primarily when investment is accompanied by improvements in productivity, technological adoption, irrigation efficiency, institutional quality, and market integration. Similar conclusions have been reported in recent ARDL-based studies showing that the growth effects of agricultural expenditure are often indirect and mediated through productivity enhancement rather than expenditure volume alone (Abate et al., 2025; Koç et al., 2025; Kaplan, 2025). The Algerian case therefore appears consistent with the emerging literature emphasizing investment quality rather than investment quantity as the principal determinant of long-run agricultural growth performance.

Moreover, recent research on structural transformation highlights that agriculture contributes more effectively to economic growth when strong linkages exist between primary production, agro-processing industries, logistics systems, and export-oriented value chains (Gollin, 2023a; Lagakos, 2023; Mabeta et al., 2025). The absence of statistically significant long-run coefficients for agricultural investment may therefore reflect incomplete transmission mechanisms rather than the absence of economic relevance. Commodity-price evidence also suggests that oil, fertilizer, food, and agricultural raw-material prices can affect growth differently across income groups, which supports the decision to control for oil prices in Algeria's resource-dependent context (Şen et al., 2024; Deyshappriya et al., 2023).

4.8 Hypotheses Assessment

The empirical findings allow a cautious assessment of the research hypotheses. H1 is only partially supported: agricultural investment shows a positive and weakly significant short-run effect after controlling for the 2017 structural break, but it does not display a statistically significant long-run effect. H2 is not strongly supported because agricultural value added does not show stable statistical significance in the preferred specification. H3 is partially supported because oil prices appear more relevant in short-run dynamics than in long-run equilibrium. H4 is supported: the inclusion of D2017 and the exclusion of 2020 alter the cointegration evidence, indicating that structural breaks and exceptional shocks matter for the estimated relationship. Overall, the hypotheses are not confirmed or rejected in a simple binary way; rather, the results suggest a conditional and shock-sensitive relationship between agricultural variables and economic growth.

4.9 Theoretical Contribution

This study contributes to the literature in several ways. First, it extends the agriculture-growth nexus literature by examining agricultural investment within a resource-dependent economy where public investment decisions are influenced by hydrocarbon revenue cycles. Second, it provides evidence that agricultural investment does not necessarily translate into sustained economic growth unless investment is converted into efficiency-enhancing capital formation and effective value-chain integration. Third, the study demonstrates the importance of accounting for structural breaks when analysing long-run relationships in economies exposed to commodity-price shocks and macroeconomic adjustments. Finally, the findings support contemporary theories of structural transformation, which emphasize factor productivity, institutional quality, and sectoral integration as key channels linking agricultural investment to economic development.

4.10 Policy Implications

The results imply that the central policy challenge is not simply to spend more on agriculture, but to convert agricultural investment into measurable productive capacity and durable linkages with the wider economy. On this basis, the following priorities are recommended:

- **Prioritize investment efficiency over expenditure volume.** Allocation decisions should be evaluated on expected output, productivity and employment returns rather than on the nominal size of budget lines, with ex ante appraisal and clear performance benchmarks for every major agricultural program.
- **Modernize irrigation and water management.** Given Algeria's semi-arid conditions, expanding efficient irrigation (drip and precision systems), rehabilitating existing networks and improving water-use productivity are decisive for translating investment into real output gains.
- **Develop storage and post-harvest logistics.** Investment in cold chains, silos and modern storage would reduce post-harvest losses, stabilize seasonal supply and raise the share of production that reaches markets in marketable quality.
- **Strengthen value-chain integration and agro-processing.** Linking primary production to food processing and distribution raises domestic value added, reduces import dependence and creates higher-productivity rural employment, helping agricultural investment register in aggregate growth.
- **Promote food manufacturing and private-sector participation.** Targeted incentives, access to finance and public–private partnerships can crowd in private capital and managerial capacity, improving the productivity of agricultural spending beyond what public outlays alone can achieve.
- **Reinforce project monitoring, evaluation and governance.** Independent monitoring-and-evaluation systems, transparent procurement and results-based disbursement would limit leakage and ensure that funds are converted into operational productive assets.

- **Link agricultural support to productivity outcomes.** Subsidies and credit should be conditioned on verifiable productivity, yield or sustainability indicators rather than disbursed unconditionally, so that support reinforces efficiency rather than entrenching low-productivity activities.
- **Reduce dependence on oil-price cycles.** Because agricultural investment co-moves strongly with hydrocarbon revenues, establishing a stable, rule-based and counter-cyclical financing mechanism (for example, a dedicated agricultural fund insulated from oil-price swings) would protect investment continuity during downturns and support long-run diversification.

5. LIMITATIONS

This study is subject to several limitations that should be considered when interpreting the findings. First, although the agricultural investment variable (AGRINV) is expressed in real (constant-price) Algerian dinars, the construction of a long real series still depends on the choice of deflator and base year. Because a consistent agricultural investment deflator is unavailable for the full 1995–2024 period, the estimated coefficients could remain sensitive to these measurement choices. Future research could test alternative deflators and base years, as well as AGRINV/GDP and AGRINV/public expenditure ratios, as complementary robustness checks. Second, the sample covers only 30 annual observations, which limits degrees of freedom and the precision of long-run coefficient estimates. Marginally significant results should therefore be interpreted cautiously. Third, the agricultural value added variable (AgriVA) is measured as a share of GDP and does not necessarily capture real agricultural production or factor productivity; a rise in this share may partly reflect contraction in other sectors rather than genuine agricultural improvement. Fourth, the study relies on standard inference without bootstrap confidence intervals or Newey-West robust standard errors as the primary estimation approach; these are recommended as complementary checks in future replications. Fifth, the ARDL framework identifies statistical associations and dynamic adjustment patterns but does not establish structural causality in the strict econometric sense, as no instrumental variable, regression discontinuity, or quasi-experimental design is employed.

6. CONCLUSION

This study examined the relationship between agricultural investment, agricultural value added and economic growth in Algeria over the period 1995–2024, while controlling for oil prices and accounting for structural breaks and exceptional shocks. The ARDL approach is appropriate because the variables are integrated of order zero or one, and no variable is found to be I(2). The baseline model provides only borderline evidence of cointegration, whereas the structural-break-adjusted model with D2017 strengthens the evidence of a long-run relationship.

The main conclusion is nuanced rather than null. Once the 2017 structural break is incorporated, agricultural investment exerts a positive and statistically significant short-run effect on economic growth (significant at the 10% level), and the bounds test supports a long-run relationship at the 5% level; the long-run coefficient of agricultural investment itself, however, is not statistically robust. Agricultural value added and oil prices also do not show stable long-run significance in the preferred specification. These findings should not be interpreted as evidence that agriculture or agricultural investment is unimportant. Rather, they suggest that agricultural investment alone may be insufficient to generate sustained growth unless it is translated into real productive capacity, efficiency gains and stronger linkages with the wider economy.

The results also suggest that the relationship between agricultural investment and growth is sensitive to Algeria's macroeconomic environment. The strong association between agricultural investment and oil prices indicates that agricultural spending may be partly influenced by hydrocarbon revenue cycles. The 2017 structural break further suggests that macro-fiscal changes after the oil-price decline affected the investment-growth relationship.

Scientifically, the study contributes by combining ARDL-ECM modelling, Bai-Perron structural-break analysis, diagnostic testing, stability testing, and robustness checks within a single empirical framework. This integrated approach is particularly useful for small annual samples and for economies exposed to abrupt fiscal and external shocks. The results show that the interpretation of the agriculture-growth relationship changes once the 2017 structural break and the COVID-19 shock are explicitly considered.

From a theoretical perspective, the results support the argument that agricultural investment in resource-dependent economies should not be evaluated only by its volume. In Algeria, agricultural investment appears to be partly conditioned by hydrocarbon revenue cycles, which may weaken its long-run productivity transmission. Therefore, the policy challenge is not simply to increase agricultural spending but to transform investment into real capital accumulation, irrigation efficiency, technological upgrading, agro-industrial integration, and productivity gains.

Future research should extend this study in several directions. First, it should refine the real agricultural investment series by testing alternative deflators and base years and by distinguishing between budgeted and executed expenditure. Second, future models should incorporate agricultural productivity, irrigation capacity, rainfall variability, mechanization, rural infrastructure, institutional quality, and value-chain indicators. Third, when higher-frequency or more disaggregated data become available, researchers should examine regional differences within Algeria and distinguish between different types of agricultural investment rather than treating agricultural investment as a single aggregate variable. Finally, future work should consider quasi-experimental or instrumental variable approaches to move beyond statistical association toward stronger causal identification of the agriculture–growth relationship.

7. APPENDICES

Appendix A provides the scatterplot matrix used for exploratory analysis. It is placed in the appendix because it is visually dense and mainly supports the preliminary correlation analysis.

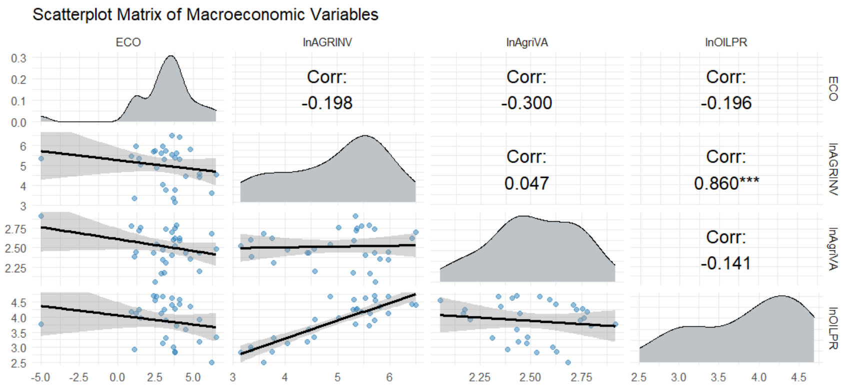

Figure 8. Scatterplot matrix of the main macroeconomic variables

Source: Author's own elaboration based on R outputs.

Appendix B. Data Construction, Measurement Robustness, And Replication Checks

The AGRINV series should be archived with source edition, table number, unit, deflator and base year, budgeted/executed expenditure status, and any harmonization decision for each year. The present article uses real (constant-price) public/sectoral agricultural investment expenditure in billion DZD, compiled from MADR and ONS publications and deflated with an appropriate price deflator, and treats this as a proxy for real agricultural capital expenditure. Alternative deflators, AGRINV/GDP and AGRINV/public expenditure ratios should be tested as further robustness checks when consistent data become available. Likewise, AgriVA is measured as agriculture, forestry and fishing value added as a percentage of GDP; future work should test real agricultural value added, agricultural value-added growth or productivity indicators. Replication scripts for residual diagnostics, outlier detection, robust/Newey-West standard errors and bootstrap checks are available from the author upon request as supplementary material.

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