The role of labour productivity within Algeria's sustainable economic development: Findings from agricultural sector

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SUMMARY

Despite Algeria's abundant natural resources, achieving sustainable growth and prosperity remains challenging. Amid this, labour productivity within the agricultural sector stands as a silent warrior, holding within its grasp the secrets to propel the Algerian economy forward. Therefore, this study tries to uncover the pivotal role of labour productivity in Algeria's agricultural sector as a beacon for sustainable economic development. Using an autoregressive distributed lag (ARDL) model from 1990–2021, the results reveal that agricultural gross production value, inflation, and population growth are significant determinants of GDP per capita in the short–run, while agricultural value added per worker also emerges as an essential long–run driver. However, agricultural employment is shown to have an insignificant impact, indicating declines in the sector's workforce and neglect in recent years. Overall, the analysis confirms the hypotheses of either short–term or long–term connections between labour productivity and sustainable economic development within Algeria's agricultural sector. These findings illuminate a pathway that suggests revitalising the labour productivity within Algeria's agricultural sector could be a key lever in transforming Algeria's economic landscape towards a more prosperous and sustainable future.

KEYWORDS

agricultural sector, Algeria, ARDL model, labour productivity, sustainable economic development

1. Introduction

"Productivity isn't everything, but in the long run it is almost everything. A country's ability to improve its standard of living over time depends almost entirely on its ability to raise its output per worker" (Batóg and Batóg, 2007). Labour productivity has always been a significant aspect of countries' development strategies. However, in the last decade, the emphasis on this factor has grown exponentially due to its crucial role in stimulating economic growth and optimizing resource utilization. This shift aligns with The United Nations Sustainable

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Development Goals (SDGs). Today, enhancing labour productivity has become a primary objective for any economy, especially in the agricultural sector. The fundamental presumption is that efficient use of production factors is not only a means of assessing workforce efficiency, but also an indicator of economic progress and welfare (Velasco–Muñoz et al., 2021). Conversely, low agricultural productivity can hinder the path to sustainable economic development by limiting the export potential of agricultural products, and increasing poverty in rural areas (Awokuse and Xie, 2015). Several studies, including those by Gołaś (2019), documented thta agriculture can contribute to economic development in a variety of ways, including as a source of income, a driver of economic activity, job creation, and a provider of environmental services. Gollin (2010) and Urgessa (2015) suggests that the rise of labour productivity is especially relevant in the spheres of material production, such agriculture, and it is the foundation of sustained economic growth. Moreover, studies like Hossain (2008); Riley and Bondibene (2016); M´baye (2022); Gusev and Koshkina (2022) demonstrated that improving labour productivity is the key for production growth and development, not just in the agricultural sector but also in the overall development of countries.

Nevertheless, in a country that is keen on achieving efficiency in resource allocation, swinging towards an agriculture export–oriented industry and creating opportunities for economic growth and development, in an era where labour productivity is widely recognized as a crucial element in the journey towards achieving sustainable economic development, one cannot fail to notice that the promotion of labour productivity in Algeria's agricultural sector has been comparatively neglected. Currently, the agricultural sector in Algeria is facing, challenging conditions characterized by a decline in the number of workers and decreased efficiency. Additionally, factors such as the utilization of outdated technology and the impact of climate change have contributed to a reduction in the sector's added value. Consequently, prioritizing the improvement of labour productivity in the agricultural sector has become crucial, as it can significantly contribute to Algeria's sustainable economic development.

While existing research provides valuable insights into the relationship between labour productivity and sustainable economic development, a significant gap remains regarding the specific case of Algeria's agricultural sector. This gap is particularly evident in the lack of studies utilizing GDP per capita to measure sustainable economic development, providing a more nuanced understanding of the relationship with labour productivity. This study addresses this research gap by employing econometric models to analyze the long–run and short–run relationship between labour productivity and GDP per capita in Algeria's agricultural sector. Consequently, this study focuses on the central question: will unlocking the potential of labour productivity within Algeria's agricultural sector release the gates to an economically sustainable future? Or will the sector continue to be neglected and become the Achilles heel that cripples development? By addressing this question, we strive to shed light on the significance of labour productivity in shaping the path towards sustainable economic development in the Algerian economy.

Using annual data from 1990–2021, this study employs an autoregressive distributed lag (ARDL) model with GDP/capita as the dependent variable, representing sustainable economic development and labour productivity indicators from Algeria's agricultural sector as the independent variables. The scope of this research centers around two hypotheses: (1) a strong and positive long–run correlation exists between an increase in crucial labour productivity indicators in Algeria's agricultural sector and sustainable economic development, as measured through indicators such as GDP per capita, and (2) in the short term, variations in

labour productivity within Algeria's agricultural sector are directly and positively correlated with changes in the nation's GDP per capita, indicating the sector's crucial role in the nation's overall economic performance.

In order to achieve the specified goal, the remainder of this study proceeds as follows. Section 2 establishes the background by briefly defining sustainable economic development and labour productivity. A review of pertinent literature is also provided, elucidating the research gap this study seeks to fill in Section 3. Section 4 delineates the methodology employed, while results are detailed in Section 5. Discussion is given in Section 6, followed by a conclusion that offers recommendations based on the findings in Section 7.

2. Sustainable economic development and labour productivity

Economic growth is a fundamental concept in economic theory, with countries striving to achieve consistent GDP growth. Historically, technological progress and population growth were considered the primary factors driving economic growth (Palić et al., 2017). However, the continued rise in population and the constraints posed by limited natural resources and food supplies of transformed these factors into significant challenges (Janković Šoja and Bucalo Jelić, 2016). To address these concerns, it has become imperative to strike a balance and reconcile the opposing forces. In this context, sustainable economic development has garnered considerable attention from researchers and policymakers.

Sustainable development emerged as a strategy to balance economic growth, environmental protection, social equality, and the rational use of natural resources in the long term. However, the definition of sustainable economic development is complex and elusive. Frequently, precision is sacrificed for acceptance in attempting to describe the environmental, economic, and social characteristics of sustainable economic development. Sustainable development is a long–term approach to economic growth that considers environmental, social, and economic factors (Barbier, 1998). The study of Bervidova (2002) has defined sustainable economic development as directly concerned with raising the material standard of living of people experiencing poverty, which can be quantified in terms of increased food and real income through providing interest in productivity in sectors such as agriculture that minimise resource depletion. Contrary to economic growth, sustainable economic development is based on increasing productivity and responsible use of resources (Brad et al., 2016).

In contrast, labour productivity is a widely used concept in economics, its interpretation and measurement can vary depending on the specific context and methodologies employed (Bezat–Jarzębowska and Rembisz, 2016). At its core, labour productivity represents the ratio between output produced and labour inputs consumed in production. However, the complexity lies in how input and output are defined and quantified. Therefore, it is a baffling economic term (Dall'erba et al., 2005). Additionally, variations in labour productivity levels contribute to divergent growth rates among countries or regions Batóg et al (2009). Labour productivity refers to the quantity of output generated per unit of labour, with labour being quantifiable in either hours worked or the count of individuals employed (Deaconu et al., 2018). Within the agricultural sector specifically, standard productivity metrics incorporate measures of yield or value–added per agricultural worker, thereby quantifying sectoral output relative to labour input (Batóg and Batóg, 2007). In other words, labour productivity is defined as output per unit of labor, where labour can be expressed as the number of hours worked, the number of individuals employed or the number of workers (Radło and

Tomeczek, 2022). Conversely, in the agricultural sector, labour productivity can be measured by the amount of agricultural output produced per unit of labour input, such as yield per agricultural worker or value added per agricultural worker.

3. Literature review

Over the years, researchers and economists have conducted numerous studies to explore the intricate relationship between labour productivity and sustainable economic development. The existing literature presents various studies that dissect this complex relationship from various angles, each contributing unique insights and highlighting different aspects of this multifaceted topic.

In research conducted by Gollin (2010) the correlation between labour productivity and sustained economic growth in developing nations from 1950 to 2010 has been examined. The author begins by discussing the importance of agriculture in developing countries, both in terms of its contribution to economic growth and its role in providing food security. This study examines theoretical arguments and empirical evidence supporting the hypothesis that enhancements in agricultural productivity have contributed to economic growth in developing countries. The author finds a strong positive correlation, suggesting that increasing labour productivity can promote economic development. Another study by Awan and Anum (2014) examined key determinants of agricultural productivity growth, and compared the effects of these factors on economic growth in a sample of seven selected nations in comparison to seven advanced countries. The researchers used a variety of econometric techniques, including time series analysis and a two–sector model, to study the economic dynamics of the variables. The study extensively analyzed multiple indicators of infrastructure, specifically focusing on the following variables: the percentage of employment in agriculture, labour productivity in the agricultural sector and aggregate labour productivity. The outcomes underscore a remarkable and positive link between labour productivity and economic growth in the context of Pakistan. The results underscore the importance of bolstering labour productivity as a driving force for promoting economic advancement.

An additional study by Awan et al. (2015) focuses on the factors influencing rural women's labour supply in agriculture, emphasising their potential contribution to economic development in the Rajanpur district of Pakistan. The study employs linear regression analysis and finds that women's participation in the labour force can increase household income, reduce poverty, and contribute to economic development. While this study offers valuable insights, it is geographically confined to the Rajanpur district in Pakistan, limiting its generalizability to broader labour productivity issues.

In research conducted by (Bezat–Jarzębowska and Rembisz, 2016), which sheds more light on factors affecting labour productivity, the study utilized a panel data model. Authors argue that enhancing efficiency can lead to increased agricultural output and productivity, which, in turn, can contribute to overall economic growth. This study offers a robust methodology, yet its approach, centered on the panel data model, might not fully capture the qualitative aspects of agricultural productivity, such as farmer well–being or environmental sustainability. In the study of Fedulova et al. (2019), the authors conducted a theoretical analysis of labour productivity in agricultural industries and its role in sustainable economic development. The primary goal of increasing worker productivity as the foundation of long–term economic development is considered. They argued that policymakers should focus on imple-

menting measures aimed at encouraging farmers to adopt practices that increase agricultural productivity in order to achieve sustainable economic development. However, their theoretical analysis needs more empirical backing from diverse geographic contexts. Ibidunni et al. (2020) have emphasized the importance and significance of labour productivity in stimulating economic growth and development, namely within the agricultural industry of Sub–Saharan Africa. This study utilises a blend of data analysis and panel regression approaches to investigate the determinants of worker productivity in this specific location between 2010 and 2017. The study's findings reveal substantial disparities in labour productivity levels and agriculture efficiency among the nations examined. The authors highlight many factors that influence worker productivity, such as infrastructure development and technology use. This research offers significant regional context, but it does not explicitly examine the example of Algeria.

Additionally, some studies examine the labour productivity in the agricultural sector and its significance in Algeria. According to the study conducted by Laoubi and Yamao (2012), the agricultural sector in Algeria is confronted with several obstacles, such as diminished efficiency, elevated production expenses, and restricted market entry. The research recognizes the significance of agriculture in Algeria's economy and its function in generating jobs, guaranteeing food security, and contributing to broader economic advancement. Nevertheless, this study needs empirical analysis and offers a full view of the many expressions of these difficulties. In their carefully designed study by Rey and Hazem (2020), conducted a meticulous analysis. They discovered that the agricultural sector in Algeria exhibits poor performance, making it one of the least productive sectors among Mediterranean nations. This article aims to assess the labour productivity in Algeria from 1984 to 2015, specifically in sectors like agriculture and hydrocarbons. The independent variable used for this estimation is the gross domestic product. The authors contend that Algeria should deliberate to foster the growth of its manufacturing and agricultural sectors. The study utilised gross domestic product GDP; however, GDP per capita is more effective in capturing the effects of labour productivity. Unlike the studies above, our study used GDP per capita as a measure, which offers a more detailed comprehension of the relationship between labour productivity and sustainable economic development. Although previous research offers valuable insights into the correlation between labour productivity and sustainable economic development, a gap exists in understanding this relationship within Algeria's agricultural sector. Therefore, this study seeks to address this deficiency by utilising an ARDL model and offering policy suggestions grounded in facts to unleash the agricultural sector's potential and contribute to Algeria's sustainable economic development.

4. Data and research methodology

The study employed the autoregressive distributed lags technique (ARDL) to analyze the impact of worker productivity in the agriculture sector on Algeria's progress towards sustainable economic growth. The analysis included a span of 32 years, from 1990 to 2021. The use of this paradigm, initially devised by Pesaran and Smith (1998) and Pesaran et al. (2001). The ARDL model is well-known for its robustness when dealing with small sample numbers, making it a suitable choice for the 32–year study period. This characteristic guarantees accurate outcomes even when there are just a small number of observations. The ARDL model is particularly advantageous since it can include variables regardless of their integration order,

whether they are I(0), I(1), or fractionally integrated (Pesaran et al., 2001). This feature is especially advantageous in our study since it enables the incorporation of variables such as GDP per capita, inflation, and others without requiring prior assessment of their integration order. The ARDL model can estimate both short-run and long-run parameters simultaneously, presenting a notable benefit (Jalil and Mahmud, 2009). This feature is highly advantageous in the study as it aims to comprehend both the immediate short–term and enduring long–term effects of labour productivity on sustainable economic development.

The dependent variable is gross domestic product per capita (GDP/capita). In contrast, the independent variables directly relate to labour productivity in the agricultural sector, including agricultural production, demographic changes, labour inputs, inflation, and agricultural labour productivity. All variables are measured as annual growth percentages, as shown in Table 1. Time–series data for all variables were collected from economic surveys in Algeria, National Statistics Office in Algeria (ONS) and statistics through the Ministry of Agriculture and Rural Development, as well as data from the World Bank database World Development Indicators (WDI) and the Food and Agriculture Organization of the United Nations (FAO).

Table 1. *Dependent and independent variables used in the study*

Variable	Description	Measurement unit	Source
GDP^{capita}	**Dependent variable** Gross domestic production per capita	annual growth (%)	WDI
GPV^{agri}	**Independent varables** Gross production value in the agricultural sector	annual growth (%)	FAO
POP	Population of Algeria	annual growth (%)	ONS
EMP^{agri}	Employed labour force in the agricultural sector	annual growth (%)	FAO
INF	Inflation in Algeria	annual growth (%)	
VAW^{agri}	Value added per worker in the agricultural sector (constant prices in USD, 2015=100)	annual growth (%)	ONS

GDP per capita annual growth percentage serves as a crucial outcome variable, offering a primary measure of economic output per individual and indicating the standard of living. This metric is particularly valuable in assessing sustainable development, as it reflects economic growth and the equitable distribution of economic gains. Enhancing this analysis involves considering several independent variables: The gross value of agricultural production, which highlights the agricultural sector's productivity and economic contribution. Algeria's population, to account for demographic impacts on agriculture and GDP. The employed labour force in agriculture, providing insights into labour productivity. Inflation rates, crucial for understanding fundamental economic change. The value added per agricultural worker, a key indicator of agricultural labour productivity. By incorporating these variables, the analysis can provide a more comprehensive understanding of Algeria's economic growth and progress towards sustainable development. This approach examines the overall economic output and delves into the factors that drive this growth, offering insights into the efficiency and equity of the economic development process.

Therefore, we were intrigued to examine the following research hypotheses:

Hypothesis 1. There exists a strong and positive long-run correlation between increase in key indicators of labour productivity in Algeria's agricultural sector and sustainable economic development, as measured through indicators such as GDP per capita.

Hypothesis 2. In the short term, variations in labour productivity within Algeria's agricultural sector are directly and positively correlated with changes in the nation's GDP per capita, indicating the sector's crucial role in the nation's overall economic performance.

Equation 1 aims to quantify the impact of agricultural gross production value, population dynamics, employment in agriculture, inflation, and value-added in agriculture on GDP per capita in Algeria.

$$GDP_t^{capita} = \beta_0 + \beta_1 GPV_t^{agri} + \beta_2 POP_t + \beta_3 EMP_t^{agri} + \beta_4 INF_t + \beta_5 VAW_t^{agri} + \varepsilon_t, \quad (1)$$

where β_0 is a constant term, while β_1, β_2, β_3, β_4 and β_5 are the regression coefficients associated with each independent variable, representing the expected impact or influence on the GDP/capita. The error term ε_t in the model represents the unaccounted factors that are not explicitly included. A general equation in the autoregressive distributed lag (ARDL) framework can be derived as follows:

$$\begin{aligned} GDP_t^{capita} = \gamma_0 &+ \sum_{i=1}^{q} \gamma_{1i} GDP_{t-i}^{capita} + \sum_{j=0}^{p} \gamma_{2j} GPV_{t-j}^{agri} + \sum_{j=0}^{p} \gamma_{3j} POP_{t-j} \\ &+ \sum_{j=0}^{p} \gamma_{4j} EMP_{t-j}^{agri} + \sum_{j=0}^{p} \gamma_{5j} INF_{t-j} + \sum_{j=0}^{p} \gamma_{6j} VAW_{t-j}^{agri} + \varepsilon_t. \end{aligned} \quad (2)$$

Equation 2 describes the ARDL model with q lags of dependent variable and p lags of independent variables (not necessary the same number of time lags for each independent variable), which captures both the short–term and long–term relationship between them. Parameter γ_0 is a constant term, while γ_{1i}, γ_{2j}, γ_{3j}, γ_{4j}, γ_{5j} and γ_{6j} are the ARDL coefficients with respect to lagged variables on the right hand side. Upon estimating the ARDL model, the subsequent stage involves examining the long–run association between the dependent and independent variables through the utilization of the F–statistic test. The null hypothesis of the F–statistic test pertains to the coefficients on the lagged dependent variables (α_1, α_2, . . . , α_k) are jointly equal to zero, indicating no long–run relationship. The alternative hypothesis suggests that at least one of these coefficients is not zero, indicating the existence of a long–run relationship. This is typically tested by asserting that the coefficient of the error correction term (ECM_{t-1}) in the reparameterized ARDL equation is zero ($H_0 : \lambda = 0$). Equation 3 illustrates the enduring, long–run relationship between the dependent and independent variables:

$$\begin{aligned} \Delta GDP_t^{capita} = \alpha_0 &+ \sum_{i=1}^{q-1} \alpha_{1i} \Delta GDP_{t-i}^{capita} + \sum_{j=0}^{p-1} \alpha_{2j} \Delta GPV_{t-j}^{agri} + \sum_{j=0}^{p-1} \alpha_{3j} \Delta POP_{t-j} \\ &+ \sum_{j=0}^{p-1} \alpha_{4j} \Delta EMP_{t-j}^{agri} + \sum_{j=0}^{p-1} \alpha_{5j} \Delta INF_{t-j} + \sum_{j=0}^{p-1} \alpha_{6j} \Delta VAW_{t-j}^{agri} + \lambda ECM_{t-1} + \varepsilon_t. \end{aligned} \quad (3)$$

If the null hypothesis is rejected in favor of alternative ($H_1 : \lambda \neq 0$) the long–run relationship exist. This suggests that the coefficient of the error correction term is significantly different from zero.

5. Results

This section presents the results of the study on the economic variables affecting Algeria from 1990 to 2021. The analysis includes various statistical methods and econometric tests to understand the relationships between considered variables. Table 2 summarizes the descriptive statistics for the variables employed in the analysis, spanning 1990 to 2021.

Table 2. *Descriptive statistics of observed variables*

Variable	Mean	Std. Dev.	Min	Max	Median
GDP^{capita}	2.17	13.02	−28.06	23.98	0.89
GPV^{agri}	3.37	9.14	−19.48	21.33	1.52
POP	−0.06	5.09	−12.95	9.23	−0.78
EMP^{agri}	1.81	3.25	1.36	2.53	1.86
INF	−2.13	2.13	−9.00	1.10	−2.80
VAW^{agri}	5.43	9.32	−17.95	30.43	4.36

The data exhibits substantial fluctuations in economic and demographic indices. The average GDP per capita, GPV in agriculture, and value–added in agriculture have all experienced a increase, whereas agricultural employment has declined. The inflation rates exhibit significant variation, whereas the population growth in Algeria remains generally steady.

The ARDL bounds testing technique necessitates that variables possess an I(0) or I(1) integration order, so unit root tests should be utilized to ascertain the integration order. In the current investigation, we apply the Augmented Dickey–Fuller (ADF) test for this aim. Hence, we cannot comprehend the results of F statistics supplied by Pesaran et al. (2001) in the presence of variables integrated into I(2). The objective is to avoid obtaining misleading regression outcomes by ensuring that none of the variables are integrated at I(2) or higher levels. I(0) indicates that the variable is stationary at its level (no differencing required), while I(1) suggests that the variable requires first differencing to become stationary.

Table 3. *Unit root tests ADF results*

	Test statistic	Critical values 1%	5%	10%	Oreder of integration
GDP^{capita}	−3.749	−3.716	−2.986	−2.624	I(0)
GPV^{agri}	−4.650	−3.716	−2.986	−2.624	I(0)
POP	−4.788	−3.716	−2.986	−2.624	I(0)
EMP^{agri}	−2.206	−3.709	−2.983	−2.623	I(1)
INF	−2.509	−3.716	−2.986	−2.624	I(1)
VAW^{agri}	−3.686	−3.716	−2.986	−2.624	I(0)

The Augmented Dickey–Fuller (ADF) test results in Table 3 suggest that gross domestic production per capita, inflation, value added per worker in the agricultural sector, and gross agricultural production are stationary. This indicates that these variables do not have unit

roots and are integrated of order zero I(0). However, the variables POP and EMP^{agri} are not stationary and display unit roots, indicating that they are integrated into order I(1). Given this information, it is reasonable to proceed with an ARDL model for the study. The next crucial step is determining the optimal lag length for the ARDL model, since it significantly influences the accuracy and reliability of the model's predictions and implications. According to three information criteria's AIC, HQIC and SBIC the optimal lag of 1 was selected.

After determining the most suitable lag length, the ARDL bounds test for cointegration was conducted. The main emphasis is on analyzing the F–statistics and critical values to ascertain the existence of cointegration, which indicates a stable long–run dependence between the variables under investigation. Understanding the integrated behavior of variables relies heavily on this particular analysis component.

Table 4. *The bounds test of cointegration*

F-statistic	Critical value	Decision
6.96	3.41	Cointegration exist

Based on the information provided, Table 4 shows the results of the bounds test of cointegration. The F–statistics value of 6.96 is higher than the critical value of 3.41, indicating the existence of cointegration at a significance level of 5%. Therefore, there is evidence of a long–run relationship among the variables.

To identify the number of optimal lags, we need to check for optimal lag lengths of the series by selecting the optimal lag length for each variable. In our case, the optimal lag lengths are lags (1,0,1,0,0,0) based on Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC).

Table 5. *Short–run and long-run estimated coefficients*

Short–run	Coefficient	Standard error	t–statistic	p–value
ΔGVP_t^{agri}	0.2857**	0.0657	4.340	0.012
ΔINF_t	−0.7021***	0.1264	−5.554	0.000
ΔPOP_t	−2.6232**	1.3392	−2.843	0.021
ΔPOP_{t-1}	−1.1567	2.7456	−1.773	0.857
ΔEMP_t^{agri}	0.8912	0.8230	1.083	0.176
ΔVAW_t^{agri}	1.6030*	1.0320	1.553	0.032
constant	1.1287***	0.1456	0.275	0.000
ECM_{t-1}	−1.1602***	0.1880	−6.171	0.000
	$R^2 = 0.923$	$\bar{R}^2 = 0.898$	$DW = 1.88$	$F_{(9,21)} = 62.34$***
Long–run	Coefficient	Standard error	t–statistic	p–value
GVP_t^{agri}	0.4136***	0.0343	4.698	0.000
INF_t	−0.3431***	0.2517	−5.947	0.000
POP_t	−0.7117	0.1175	−1.714	0.113
EMP_t^{agri}	0.7115	0.2395	4.350	0.571
VAW_t^{agri}	1.8167**	1.3215	1.311	0.018
constant	−0.8317***	0.3430	−2.424	0.000

Note: *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$ denote 10%, 5% and 1% significance levels

Table 5 displays the outcomes of the ARDL(1,0,1,0,0,0) bounds testing method. The model was chosen using the Akaike Information Criterion and Bayesian Information Criterion. In the short–run, gross value agricultural production is positively and significantly impacted at the 5% significance level by a coefficient of 0.2857. This coefficient implies that a 0.2857–unit increase in GDP per capita is caused by every 1–unit increase in gross value agricultural production. Although vivacious, the impact of value–added per worker and employed labour force in the agricultural sector on GDP per capita is not statistically significant. In the case of inflation, a significant reduction in GDP per capita at the 1% significance level is caused by a coefficient of −0.7021. Population growth is shown to have a significant negative effect in the current period, while its lagged effect remains insignificant. Lastly, the error correction mechanism (ECM) is characterized by a coefficient of −1.1602, which is significant at the 1% level and suggests a substantial adjustment towards equilibrium.

In the long–run, gross value agricultural production positively and significantly impacts GDP per capita. A one–unit increase in agricultural gross production value is associated with a 0.4136-unit increase in GDP per capita. Inflation negatively and significantly affects GDP per capita, implying that persistent inflation erodes purchasing power and hinders economic development. Algerian population has a negative and statistically significant relationship with GDP per capita. This suggests that rapid population growth can strain resources and limit productivity, impeding economic development and negatively impacting GDP per capita. The employed labour force in the agricultural sector exhibits a positive relationship with GDP per capita in the long–run, but this association is statistically insignificant. However, the lack of statistical significance indicates that this relationship is uncertain. Value added per worker in the agricultural sector positively and significantly contributes to GDP per capita. This suggests that enhancing the value-added component of agricultural production can significantly contribute to long-term economic growth and boost GDP per capita. These findings suggest that agricultural output growth, value–added enhancement in agricultural production, and controlling inflation are vital strategies for promoting long–term economic development and improving GDP per capita in Algeria.

Cumulative Sum of Recursive Residuals (CUSUM) and Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ) tests were performed to assess the stability of the chosen ARDL model (Figure 1).
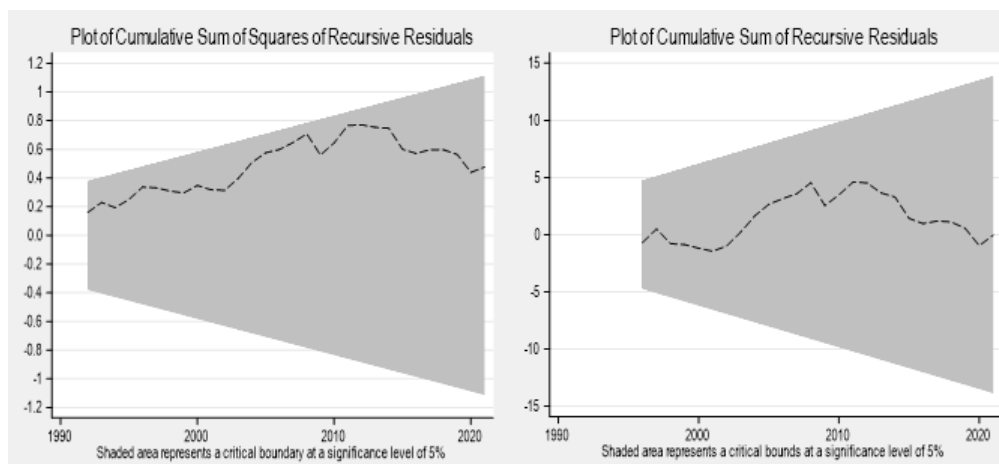

Figure 1. *CUSUM and CUSUMSQ plots*

The CUSUM and CUSUMSQ statistics plots are inside the crucial bounds at the 5% significance level, demonstrating that all coefficients in the error correction model are stable over time. Thus, the model utilised in the study seems to be good enough and robust in evaluating the short and long–run links between labour productivity in Algeria's agricultural sector and sustainable economic development. Along with stability test, a common diagnostic checking was obtained considering residuals of estimated ARDL model. This includes normality test of Jarque–Bera, Breusch–Godfrey LM and Durbin's alternative tests of the serial autocorrelation as well as Breusch–Pagan/Cook–Weisberg and White's tests of homoskedasticity (Table 6).

Table 6. *Diagnostic checking results*

Test type	Test statistic
Jarque–Bera test	1.435
Breusch–Godfrey LM test	5.02
Durbin's alternative test	0.008
Breusch–Pagan/Cook-Weisberg test	5.20
White's test	31.00

Output in Table 6 supports the null hypothesis of a normal distribution according to Jarque–Bera test. Likewise, the null hypothesis is not rejected for all other performed tests, demonstrating the fulfillment of all assumptions with respect to residuals of the ARDL model. Namely, the null hypothesis of no serial correlation was not rejected in either tests (Breusch–Godfrey LM test and Durbin's alternative test) which indicates that the residuals of the estimated mainstream ARDL model are independently distributed. It is essential to note that the tests for heteroskedasticity, the Breusch–Pagan/Cook–Weisberg and White's test respectively, do not provide significant evidence of heteroskedasticity at significance level 5%. This means that the assumption of homoskedasticity holds based on these results.

6. Discussion

The present research has yielded substantial results with critical implications for policy and practice in this field. One of the key findings of our study is the positive correlation between GDP per capita and agricultural productivity. This result aligns with prior research conducted by (Thirtle et al., 2003; Mozumdar, 2012; Zakaria et al., 2019) which reported similar associations. By confirming these previous findings, this study contributes to the growing body of evidence supporting the relationship between these variables. Results indicate that population growth has no significant impact on agricultural productivity in the short–term, but it can have a positive impact on agricultural productivity in the long–term. This study aligns with the understanding that the influence of population expansion on agricultural production is contingent upon several factors, such as the accessibility of land, water, and other resources, as well as the level of investment in agricultural research and development (Thirtle et al., 2003). On the other hand, this contradicts a study conducted by Chemingui and Ayadi (2003) which found that population growth led to decreased agricultural productivity. For this reason, in the case of Algeria, the population is expected to grow from 44.18 million in 2021 to 50 million by 2050. Algeria's investment in agricultural research and development, infrastructure, and population growth can lead to higher agricultural productivity, and vice versa.

In addition, this study also revealed a surprising discrepancy with the results reported by Rey and Hazem (2020). While they found that agriculture has experienced substantial productivity gains, our findings revealed a terrible decline in labour productivity in the agricultural sector in Algeria and, even more, a weak effect on the number of workers employed in the agricultural sector. This decrease can be attributed to several factors, such as the age of the tools used by the labour force and the decline in the number of workers in the agricultural sector. This indicates the neglect of Algeria for this sector in recent years. Furthermore, the fact that inflation has a negative and statistically significant influence on GDP per capita shows that inflation might lead to a lower GDP per capita. This is plausible because inflation can erode purchasing power by causing prices to rise and wages to lag behind prices. This can lead to decreasing demand for products and services, and as a result, economic development may suffer. Also, the positive and statistically significant effect of agricultural employment on GDP per capita implies that increasing agricultural employment might lead to increased GDP per capita. This is probable because agricultural employment may lead to increased salaries and profits, which can be invested in other areas of the economy. Moreover, the positive and statistically significant relationship between value added per worker in agriculture and GDP per capita shows that boosting productivity can lead to increased GDP per capita. This is likely because better productivity may cause more significant profits, which can be utilised to invest in other areas of the economy. The findings suggest that labour productivity is crucial for Algeria's journey towards sustainable development, particularly in the economic dimension. Policymakers can prioritise resource allocation and implement strategies to enhance productivity and efficiency in the agricultural sector based on the positive correlation we found between labour productivity and variables such as gross value agricultural production and employed labour force in agriculture.

Additionally, controlling inflation and promoting agricultural employment and productivity are essential for higher GDP per capita. As a result, both hypotheses are supported by the empirical evidence from the study. Labour productivity in Algeria's agricultural sector plays a crucial role in driving sustainable economic development and overall economic performance, both in the long and short run. In Algeria's agricultural sector, there is strong evidence for a positive long-term relationship between rising critical indicators of labour productivity and long–term economic growth, as measured by GDP per capita. This is evident in the positive and statistically significant relationship between agricultural value added, a key indicator of labour productivity, and GDP per capita in the long run. Enhancing the value–added component of agricultural production can significantly contribute to long–term economic growth and boost GDP per capita. The findings confirm the existence of a direct and positive correlation between variations in labour productivity within Algeria's agricultural sector and changes in the nation's GDP per capita in the short–term.

7. Conclusions and recommendations

This study delved into the crucial relationship between labour productivity in Algeria's agricultural sector and its implications for sustainable economic development from 1990–2021. By utilizing the autoregressive distributed lag (ARDL) model and examining variables such as GDP per capita, employed labour force, inflation, and agriculture value added, this research has shed light on the potential of labour productivity to pave the path towards sustainable economic development in Algeria. The paper comes to several conclusions that could be

summarised as follows. First, the CUSUM and CUSUMSQ tests supported ARDL long–run and short–run estimated coefficient stability throughout the observed period. Second, the findings suggest a positive long–run relationship between GDP per capita and gross production value (agricultural value added per worker) in the agricultural sector. Conversely, a negative long–term relationship was found between Algeria's GDP per capita, inflation, and population. Third, the short–run estimates confirmed that changes in gross value agricultural production have a positive and significant impact on gross domestic product per capita. On the contrary, the employed labour force in the agricultural sector, the population of Algeria, and the value added per worker in the agricultural sector do not exhibit statistically significant relationships with agricultural labour productivity and its effect on gross domestic production per capita. Given these points, it can be asserted that the agriculture sector in Algeria exhibits notably inferior productivity compared to other segments of the economy. Furthermore, the enhancement of efficiency within the agricultural sector and the adoption of developmental strategies to bolster the competitiveness of local agriculture can only be realized through the elevation of labour productivity. Therefore, boosting labour productivity in Algeria's agricultural sector is crucial for sustainable economic development.

Given the outcomes revealed, we strongly recommend that policymakers prioritize initiatives to motivate farmers to adopt methods that enhance agricultural productivity. This approach is pivotal for sustainable agricultural growth. Furthermore, adopting cutting–edge agricultural technologies is not just a choice but a necessity. It is a crucial driver for boosting agricultural productivity and value-added aspects, paving the way for a more innovative and efficient agricultural landscape. The Algerian government stands to benefit significantly by strategizing to augment workforce participation in the agricultural sectors. This can act as a catalyst for economic upliftment. To complement these strategies, providing tangible support to farmers is crucial. Tailored tax incentives, accessible loan options, and robust marketing assistance are instrumental in elevating labour productivity. These measures will empower farmers and contribute to the broader goal of economic resilience and prosperity in the agricultural sector.

Future research should explore the impact of technological advancements on labour productivity in agriculture, promoting sustainable economic development. This analysis can provide insights into how innovative technologies enhance productivity and long–term sustainability.

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Uloga produktivnosti rada u održivom gospodarskom razvoju: nalazi iz alžirskog poljoprivrednog sektora

SAŽETAK

Unatoč bogatim prirodnim resursima Alžira, postizanje održivog rasta te prosperiteta i dalje su izazovni. Usred toga, produktivnost rada unutar poljoprivrednog sektora stoji kao tihi ratnik, držeći u svom dohvatu tajne za pokretanje i unaprjeđenje alžirskog gospodarstva. Stoga ova studija nastoji otkriti ključnu ulogu produktivnosti rada u alžirskom poljoprivrednom sektoru kao svjetioniku održivog gospodarskog razvoja. Koristeći autoregresijski model s distribuiranim pomacima (ARDL) od 1990. do 2021. godine, rezultati otkrivaju da su bruto vrijednost poljoprivredne proizvodnje, inflacija i rast stanovništva značajne determinante BDP-a po glavi stanovnika u kratkom roku, dok je poljoprivredna dodana vrijednost po radniku također signifikantan dugoročni pokretač. Međutim, zapošljavanje u poljoprivredi ima beznačajan utjecaj, što ukazuje na smanjenje radne snage u tom sektoru i njihovo zanemarivanje posljednjih godina. Sveukupno, analiza potvrđuje hipoteze o kratkoročnim i dugoročnim povezanostima između produktivnosti rada i održivog gospodarskog razvoja unutar alžirskog poljoprivrednog sektora. Ovi nalazi osvjetljavaju put koji sugerira da bi revitalizacija radne produktivnosti unutar alžirskog poljoprivrednog sektora mogla biti ključna poluga u transformaciji alžirskog gospodarskog krajolika prema prosperitetnijoj i održivoj budućnosti.

KLJUČNE RIJEČI
poljoprivredni sektor, Alžir, ARDL model, produktivnost rada, održivi gospodarski razvoj