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Determinants of Food Security in Algeria: An Econometric Study Using the ARDL Model

Dekkiche Djamal, Khelifa Hadj, Laila Oulad Brahim

Abstract

This study examines the determinants of food security in Algeria from 1990 to 2021, using the Food Production Index (FPI) as a proxy and an autoregressive distributed lag (ARDL) framework as the analytical tool. The set of explanatory variables comprises the area of land under cereal production (in hectares), the inflation rate, the exchange rate, and gross fixed capital formation (GFCF). Particular attention is paid to the link between food prices and the competitiveness of the Algerian food sector, given the country's persistent reliance on imports. The results reveal a long-run equilibrium relationship among the variables and indicate that land under cereal production, gross fixed capital formation, and the exchange rate exert a statistically significant influence on food prices in both the short and long run, while inflation has a negative but statistically insignificant effect. A Zivot–Andrew's test identifies a structural break in 2019, which the model accommodates without loss of stability. The study finds that improving competitiveness in Algeria's food sector calls for sustained agricultural investment, firm control of inflation, and stronger resource-use efficiency, all of which together support the stability of food prices. From a policy and competitiveness perspective, the study recommends formulating an effective monetary policy that supports food production and curbs the inflationary pressures threatening food security. Greater attention should also be devoted to promoting Algerian exports and to building a strong domestic food sector capable of substituting imports in both quality and quantity. Stabilizing the exchange rate would encourage investment, reduce import dependence, and help to contain food-price inflation. Finally, redirecting attention to productive farmland is essential for achieving economic diversification and a more competitive food-security base.

Keywords: *Inflation Rate, Exchange Rate, GFCF, Competitiveness, Imports*

JEL Classification : L25, P24, O24, P42.

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1. INTRODUCTION

The issue of food security is considered one of the most important strategies on which international and national relations are based in the field of planning to preserve the human security of peoples and societies and ensure their stability, considering food as the basis for the continuation of human life in light of the developments related to the Covid-19 epidemic and the current Russian-Ukrainian crisis, as both countries displace global leaders in grain exports.

Food security is one of the foundational dimensions of economic competitiveness. A country's ability to deliver food at stable prices reflects how efficient its productive sector is and how resilient that sector remains in the face of shocks. For this reason, examining the determinants of food prices offers a useful entry point for assessing the level of competitiveness of the Algerian economy.

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Algeria seeks to achieve its food security so that it can reduce the economic dependency that threatens the security of many countries. The goal of the Algerian government is to determine the effective new policies that the authorities can adopt to contribute to raising the level of food security. The paradox lies, however, in the fact that the local supply of food production has long remained unable to even meet the local demand for the main products. Therefore, imports are used to cover the food deficit to maintain the issue of food security at the national level. This is particularly the case for petroleum-dependent economies. Those interested in the sectoral composition of the Algerian economy may clearly notice that the Algerian economy is an oil-based rentier system that relies heavily on hydrocarbon exports, which are estimated at approximately 98 % of Algeria's total foreign currency earnings, making the process of relying on food imports to bridge the food gap a serious matter in terms of Algerian food security in the long and medium term, especially in light of the significant decline in crude oil prices. In essence, we sought through this study and in the light of the results reached herein to identify and address the variables that may affect the future of food security in Algeria. Decision makers in Algeria will accordingly be able to address the problem of food security and break down the dependency abroad in the field of food, especially in light of the change of geopolitical conditions around the world, namely, the Russian-Ukrainian war and the future of wheat, which has become threatening to the lives of millions of people world wide.

Although a sizeable amount of literature has examined the drivers of food prices, comparatively few studies have linked those drivers to the broader notion of competitiveness, and even fewer have done so for developing economies. Applied work on Algeria remains particularly thin, especially studies that adopt modern econometric techniques and incorporate variables such as gross fixed capital formation as a determinant of food-sector performance. This paper sets out to fill that gap. It uses food prices as a proxy for food security and connects them empirically to the level of competitiveness, while accounting for macroeconomic factors and for structural breaks in the series.

2. PREVIOUS STUDIES

A literature review was conducted to discover information sources. Many research studies address the issue of food security, focusing on determinants at the household or national level. Variables used may vary across studies. In Morocco, factors affecting food security include national food production, rainfall, food prices, Gini index, exports, and local health environment (Aker et al., 1999). Household size is also important for household-level food security.

A review of the empirical results in Aidoo et al. (2013) reveals that household size is adversely related to food security. As in other studies, household size in relation to food insecurity at the household level gives a positive and indeed significant result (Gebre, 2012). By contrast, a review of the empirical results for rural households in Africa shows that household size harms food insecurity (Amaza et al., 2008).

A study conducted by Applanaidu et al. (2014) investigated the relationship between factors and food security in Malaysia. They used the VAR (vector autoregression) methodology to analyze variables, including biodiesel production, exchange rates, Malaysia's GDP, government expenditure on the development of the food price index, and Malaysia's population. The findings from their analysis using variance decomposition showed that biodiesel production, exchange rates, and government spending on development had an impact on food security. This impact was particularly pronounced in 2014, with observed changes in

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population, exchange rate, and GDP. This model provides insights into understanding how food security is influenced by interactions between global markets. Moreover, it offers a way to assess food security by identifying specific variables that have a major impact at a national level. This could be beneficial for both consumers and policymakers.

The research conducted by Ceesay and Ben Omar Ndiaye (2022) delves into the effects of climate change on domains, including food security, economic growth, population growth, and the agricultural sector. The study utilized data from the World Development Indicator (WDI) database covering the period from 1971 to 2020. Various analytical methods were employed to analyze this data, such as the vector autoregressive approach (VAR), Granger causality approach, autoregressive distributed lag technique (ARDL), and error correction model (ECM).

A World Bank study by Butzer et al. (2010) argues that fixed capital is a cornerstone of agricultural production. Its accumulation through investment in machinery, infrastructure, and modern farming technologies raises productivity and improves resource-use efficiency. The supply-side effect is favorable: rising output expands the available stock of food commodities, eases pressure on prices, and helps stabilize the food price index. From a competitiveness standpoint, gross fixed capital formation in agriculture can therefore be read as a decisive factor for price equilibrium and for containing food-price volatility.

Samal et al. (2022) draw attention to the role of macroeconomic factors in shaping food-price dynamics. Drawing on an ARDL specification to capture both short- and long-run relationships, they show that higher income and aggregate investment indirectly stimulate demand and push food prices upward, whereas the greater food availability produced by stronger agricultural output works in the opposite direction and pulls prices down. Investment — and in particular agricultural fixed capital such as equipment, irrigation systems, and infrastructure — therefore plays a pivotal role in widening food supply and easing inflationary pressures on the food price index. The net effect of fixed capital investment thus emerges as positive but indirect: it supports production and dampens food-price inflation, both of which strengthen sectoral competitiveness.

Extensive research has shown that the growth of food security is closely linked to the development of the agriculture sector. On the one hand, fluctuations in rainfall have an impact on food security. Additionally, while population growth initially has an effect on food security, its long-term impact is relatively insignificant. Based on these findings, it is recommended that rural Gambia focus on agriculture as a means to enhance food security. To achieve this goal and promote farming practices, the government should prioritize intervention programs for improving food security initiatives aimed at reducing poverty levels, providing indicators of adaptive capacity, and ensuring access to affordable and high-quality education for all individuals.

Moreover Jeder et al. (2020) highlighted that the issue of food security is receiving recognition in middle-income countries like Tunisia, particularly following the 2011 revolution. This significant event has amplified factors that impact food security. To carry out their analysis on this topic, they utilized the vector error correction model approach (VECM). The findings of this methodology indicate a substantial and enduring causal connection between the dependent variables and the explanatory variables. Additionally, evidence exists of a temporary causal association between food security and independent variables such as the amount of land dedicated to cereal production, food imports, and inflation. The findings confirm that the issue of ensuring food in Tunisia is a concern for the long run. Tunisia must take action to protect

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food security in times of crisis. This includes implementing strategies like managing inflation, decreasing reliance on imported food, and adopting practices that preserve and improve the fertility of farmland used for growing cereal crops. Additionally, addressing the impacts of climate change is also important.

Nutrition plays a role in ensuring our survival. It is crucial for both human well-being and economic advancement. Nigeria faced challenges in terms of food security due to the oil boom in the 1970s, which resulted in a significant shift of labor and resources away from agriculture. A study conducted by Oke (2015) examines the factors that influence food security at the national level in Nigeria.

The research highlighted difficulties encountered by the food sector in the economy, such as policies, excessively high production expenses, a robust currency value, and an expanding population. These elements contribute to forces impacting food prices, gradually undermining Nigeria's food security situation. This study suggests that the food security situation in Nigeria might be significantly enhanced by reducing the cost of agricultural output and lowering the prevailing exchange rate in the country. It further suggests that aligning food production with the rapid population expansion is crucial to mitigating the country's high poverty rate. This makes it abundantly evident that the availability, access, utilization, and stability of food that is nutritionally appropriate are all included in food security.

More recent contributions have refined this picture. For the Maghreb region, Mohamed et al. (2024) use a panel framework covering Libya, Tunisia, Algeria, Morocco, and Mauritania over 2003–2018 and report that gross domestic product, arable land area, and agricultural exports all exert a positive and significant effect on agricultural performance, the proxy they use for food security. Khalifa (2025) applies an ARDL model to Tunisia for 1990–2022 and shows that lagged agricultural productivity contributes significantly to economic growth, while rainfall variability undermines the country's rain-fed system — both findings that reinforce the competitiveness implications of supply-side capacity. Bloem and Farris (2022), reviewing COVID-19 evidence, document widespread food-security setbacks across low- and middle-income countries, providing a useful backdrop for the structural break that the present study identifies in 2019.

While much of the existing literature focuses narrowly on the determinants of food prices, its findings translate naturally into a competitiveness framework: rising agricultural productivity and more efficient use of resources are themselves among the most important determinants of the agricultural sector's competitive capacity.

3. METHOD AND TOOLS

To investigate the factors influencing food production in Algeria, an econometric model was used during the period 1990-2021, according to the following methodology:
Determining the model of interest;
Analyzing the descriptive statistics of the model variables;
Testing the stability of the variables;
Estimating the ARDL boundary test;
Determining the short-run and long-run relationship;
And performing some diagnostic tests for the model of interest.

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3.1. Study variables

The following food security factors were employed in this study from 1990 to 2021:

- Food production index [Index Value] (2004-2006=100). This index includes crops that may be eaten and have nutritional value. Coffee and tea are eliminated due to their lack of nutritional value, although being edible.
- Inflation (INF), consumer price index (CPI) (annual %), as measured by CPI, reflects the change in the annual percentage that the average consumer must pay to purchase a basket of goods and services.
- Cereal production statistics (LCER) specifically focus on the production of cereals harvested for grain. This data excludes cereal crops used for grazing and those collected for hay or green, for food, feed, or silage purposes.
- Gross fixed capital formation (GFCF) is an indicator of the volume of investment in fixed assets within the economy over a given period.
- Algeria's exchange rate regime EXCH: the exchange rates of the United States dollar (USD) vs. the Algerian dinar (DZD).

The information for the study came from the World Bank website. (*Food production index (2014-2016 = 100) - Algeria | data*, n.d.)

3.2. Study model

Food security encompasses four elements: ensuring a food supply, enabling access, promoting proper utilization of food, and maintaining the stability of food resources. (FAO Publ. Cat. 2022, 2022). Food production refers to the process by which a country produces food for its inhabitants, either solely through domestic means or through a combination of domestic and international sources. For nearly all countries, national food production is the primary factor in ensuring national food security in terms of quantity (FAO Publ. Cat. 2022, 2022). Inadequate food supply will result in widespread hunger and famine within a nation. Thus, an empirical framework will be employed to gauge food security in relation to food production.

As a result of the conversation regarding the factors that could potentially determine food security, we made use of the studies conducted by Jeder et al., (2020) and Mahrous (2019) on Tunisia's food security determinants, which is a country somewhat geographically close to Algeria. The model can be written for Algeria after adopting the logarithm. The study variables are homogeneous, especially in terms of units of measurement. Inserting the logarithm into the model allows it to be converted into a linear model as follows:

$$\boldsymbol{LnFPI_t = \alpha_0 + \alpha_1 lnLCER_t + \alpha_2 lnINF_t + \alpha_3 lnEXCH_t + \alpha_4 lnFBCF_t + \varepsilon_t}$$

The study variables are summarized in **Error! Reference source not found.**.

Tab. 1 – Introduction to study variables. Source: own research.

Variable	Code	Definition
FPI	Food production index (2004-2006=100)	Food production index
INF	Inflation, consumer prices (annual %)	Inflation, consumer prices
LCER	Land under cereal production (hectares)	Land under cereal production (hectares)
GFCF	Gross fixed capital formation (current US$)	An indicator that reflects the volume of investment in fixed

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		assets within the economy over a given period.
EXCH	Official exchange rate (LCU per US$, period average)	Official exchange rate (DZD per USD, period average)
Coefficients	α_0 , α_1 , α_2 , α_3	The coefficient for the explanatory variables
ε_t	Error term	Model Coefficients

3.3. Descriptive analysis of study variables

The descriptive analysis provides a general overview of the trends of the variables under study from a statistical standpoint, in addition to testing their normality using the coefficient of skewness, kurtosis, and the Jarque–Bera test.

The findings obtained are represented in **Error! Reference source not found.**.

Tab. 2 – Descriptive analysis of model variables. Source: own research.

	FPI	LCER	INF	EXCH
Mean	66.57813	2611768.	8.559418	68.85649
Median	58.62500	2697837.	4.654329	72.79265
Maximum	112.3100	3663945.	31.66966	126.7768
Minimum	31.08000	1058184.	0.339163	7.608558
Std. Dev.	27.87478	725767.5	9.179278	30.87373
Skewness	0.389042	-0.603419	1.506134	-0.236017
Kurtosis	1.583647	2.533985	3.803783	2.713593
Jarque-Bera	3.481962	2.231501	12.95977	0.406461
Probability	0.175348	0.327669	0.001534	0.816090
Sum	2130.500	83576584	273.9014	2203.408
Sum Sq. Dev.	24087.10	1.63E+13	2612.033	29548.81
Observations	32	32	32	32

According to the data presented in **Error! Reference source not found.**, it is evident that the FAO Food Price Index (FFPI) had a score of 4.11 points throughout the study duration. The FFPI is a measure used to analyze the changes in prices for important food items. This index is calculated by averaging the price indices of five commodity groups, with their weights determined by the export proportions of each group from 2014 to 2016. It witnessed an increase during the entire study period in Algeria, where it recorded 104.62 points as a maximum value in 2021 (**Error! Reference source not found.**). This indicates a rise in food prices in Algeria due to weak local agricultural production, which in turn is due to a number of reasons, including neglect of this strategic sector, given the country's reliance on fuel as the sole source of income, in addition to drought and scarcity of rain.

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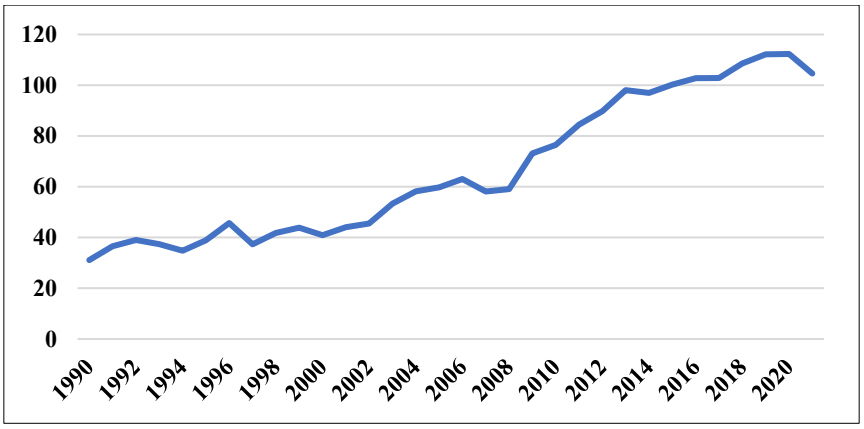

Figure. 1– Food price index in Algeria**.** Source: own research based on World Bank data.

Regarding the size of land under cereal production, the area of arable land (% of land area) in Algeria out of the total area is estimated at 3.1%, while the percentage of irrigated agricultural land is estimated at 2.6%, which is a weak indicator and evidence that most of the land depends on rainwater.

In the face of land under cereal production vulnerability, it has become necessary to increase the land under cereal production by establishing new farms in desert areas where water is available, while reducing fallow areas using fertilizers on a large scale, introducing agricultural machinery, and raising local seed production from three million to four million quintals, by expanding the condensation network and its areas, as well as filling water through dams and reservoirs along with exploiting groundwater.

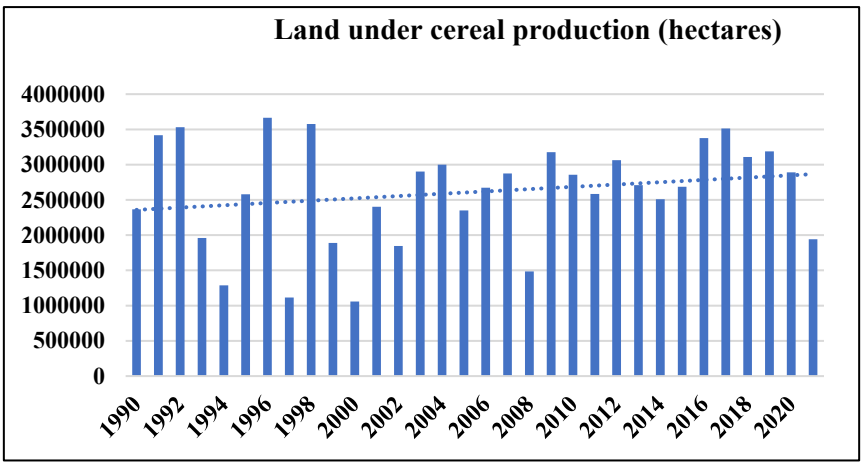

Figure. 2–Size of land under cereal production in Algeria (hectares). Source: own research based on World Bank data.

Regarding population, total (POP), the National Bureau of Statistics estimated the country's population in early 2021 at approximately 44.7 million, compared to 43.9 million in early 2020, with a growth rate of approximately 1.82%. The sex ratio at birth (SRB) in 2020 was around 104 male births per 100 female births. Adding to this, since the 1990s, the country has experienced a lack of access to land due to the intensified rural exodus as a consequence of the so-called "Black Decade."[1] Consequently, agriculture has been devastated, and rural

[1] Algerian Civil War

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populations no longer have the desire to work in the field, as the labor force in the agricultural sector is considered small, if in some cases it even exists, and is, in most cases, unqualified. As for IMF, it recorded a decline since 1992, when it reached a value of 31.66%, which is the highest during the study period. This increase is attributed to the external debt, especially with the beginning of the security crisis that Algeria experienced in light of the negotiations with the International Monetary Fund (IMF), and with the recovery of the Algerian economy at the beginning of the millennium. Inflation rates witnessed a significant decline, reaching 0.33% in 2000, and then remarkable increases of varying degrees, especially with the financial crisis in 2008 and the collapse of oil prices in the second half of 2014, as well as the COVID-19 pandemic crisis at the beginning of 2020.

4. RESULTS AND DISCUSSION

4.1. Validation of the model: Ramsey RESET Test

The Ramsey RESET test was conducted to verify the correct specification of the econometric model. As reported in Table 3, the associated probability is well above 0.05, so the null hypothesis of correct specification cannot be rejected.

Tab. 3 – Ramsey RESET Test. Source: own research.

Equation: UNTITLED			
Specification: LNFPI LNFPI (-1) LNINF LNLCER LNGFCF LNGFCF(-1)			
Omitted Variables: Squares of fitted values			
	Value	**df**	**Probability**
t-statistic	0.559203	23	0.5814
F-statistic	0.312708	(1, 23)	0.5814

According to the results in Table 3, there is no evidence of functional-form misspecification or of relevant variables being omitted, which confirms the soundness of the model employed in this study.

4.2. Correlation matrix

As shown in Table 4, the bilateral correlations between the dependent variable LNFPI and each of the explanatory variables (LNLCER, LNINF, LNGFCF, LNEXCH) point in the expected directions. Among the explanatory variables themselves, the highest pairwise correlation is observed between LNINF and LNEXCH (–0.66), followed by LNGFCF and LNEXCH (0.59); all remaining cross-correlations lie below 0.35. These values fall well within the conventional 0.80 threshold above which severe multicollinearity is usually suspected, so no explanatory variable needs to be dropped on these grounds.

Tab. 4 – Correlation matrix between variables. Source: own research.

	LNFPI	**LNINF**	**LNLCER**	**LNGFCF**	**LNEXCH**
LNFPI	1,00				
LNINF	-0,35	1,00			
LNLCER	0,38	0,25	1,00		
LNGFCF	0,94	-0,25	0,34	1,00	
LNEXCH	0,75	-0,66	0,07	0,59	1,00

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We additionally note that the population variable initially considered as a regressor was excluded in the present specification: in preliminary runs, it generated unacceptably high pairwise correlations and induced first-order autocorrelation in the residuals. Replacing it with gross fixed capital formation produced the well-behaved correlation structure reported here, the absence of error autocorrelation confirmed by the Durbin–Watson and Breusch–Godfrey tests below, and clear improvements in the model's diagnostic statistics.

4.3. Test for Stationarity in Time Series

The test for stationarity in time series aims to examine the properties of the time series for both the dependent variable (lnFPI) and the independent variables (lnLCER, lnINF, LnEXCH, lnGFCF) during the period 1990-2021, ascertain the extent of their stationarity, and determine the degree of integration of each variable over the period 1990-2021 (Sheikhi, 2013, p. 124). The results are summarized in **Error! Reference source not found.**.

Tab. 5 – Test for Stationarity in Time Series. Source: own research.

			lnFPI	**lnLCER**	**lnINF**	**lnGFCF**	**LnEXCH**
ADF test	Level	T-Stat	-0.9961	-2.3108	-2.5895	-2.963972	-5.0308
		Prob	0.7422	0.1757	0.1058	0.7079	0.0003
	First Diff	T-Stat	-6.2785	-8.5917	-7.6904	-2.963972	
		Prob	0.0000**	0.0000	0.0000**	0.0011**	
PP test	Level	T-Stat	-0.9901	-5.6079	-2.4564	-2.960411	-5.5300
		Prob	0.7443	0.0001	0.1355	0.8633	0.0001
	First Diff	T-Stat	-5.3872	-11.8808	-7.8584	-2.963972	
		Prob	0.0000**	0.0000**	0.0000**	0.0011**	
Order of integration			1	1	1	1	0
Optimal Lag lenght[1]			1	1	1	1	1

As can be noticed from the results of **Error! Reference source not found.**, all the variables are non-stationary at the level given the reliability of acceptance at a 5% significance level (p-value > 0.05), except for EXCH. The variables, however, are stationary after differencing them once, which means that they are a mixture in the integration between I(0) and I(1). Thus, the results reveal an urge to estimate the ARDL boundary test.

The ADF and Phillips–Perron (PP) tests assume that the time-series structure remains constant over the sample period. When abrupt structural changes occur — for example, as a result of economic shocks or exceptional events — these conventional tests may prove insufficient, and overlooking such breaks can lead to misleading inferences about the presence of a unit root. To obtain a more reliable picture of stationarity, we therefore complement the conventional tests with the Zivot–Andrews procedure, which allows for an unknown endogenous structural break in the series and so improves the robustness of the stationarity results.

4.4. Zivot-Andrews Unit Root Test

The Zivot–Andrews test was applied to assess the stationarity of the food price index series while allowing for a structural break. The associated probability is below 0.05, which leads us to reject the null hypothesis of a unit root.

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Tab. 6– Zivot-Andrews Unit Root Test. Source: own research.

Date: 04/18/26 Time: 18:04		
Sample: 1 32		
Included observations: 32		
Null Hypothesis: LNFPI has a unit root with a structural break in the intercept		
Chosen lag length: 0 (maximum lags: 4)		
Chosen break point: 20.00000		
	t-Statistic	**Prob. ***
Zivot-Andrew's test statistic	-4.122178	0.005950
1% critical value:	-5.34	
5% critical value:	-4.93	
10% critical value:	-4.58	
*Probability values are calculated from a standard t-distribution		
and do not take into account the breakpoint selection process		

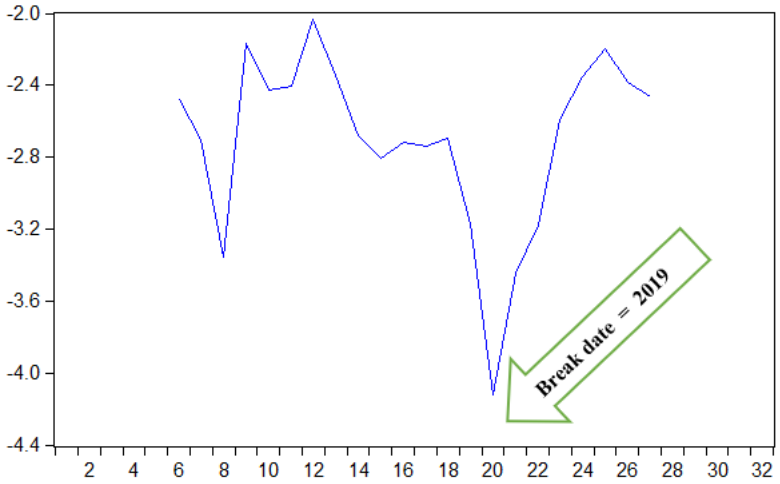

Figure. 3–Structural break**.** Source: own research.

Once the structural break is taken into account, the food price index series is stationary at the level, and the test identifies 2019 as the break point. This break can be read against the economic and political developments that Algeria went through during that period, in particular the oil-price fluctuations and their pass-through to the domestic economy. The same period also coincides with early disturbances in global markets associated with the onset of the COVID-19 pandemic, which disrupted supply chains and raised food commodity prices.

4.5. Boundary Test

The ARDL bounds testing approach to cointegration was first introduced by Pesaran et al., (2001). This method can be applied regardless of whether the predictor is I(0), purely I(1) or mutually cointegrated. The examination employs a used measure called the Wald or F statistic in the framework of a Dickey-Fuller regression. This F statistic is used to evaluate the significance of levels of the variables being studied in an equilibrium correction model (ECM).

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The bounds test provides two sets of asymptotic critical values for the two cases: one that assumes that all regressions are I(1) and the other that assumes that they are I(0).
The results of ARDL bounds testing using the Eviews package are summarized below (**Error! Reference source not found.**):

Tab. 7– ARDL Bounds Test. Source: own research.

F-Bounds Test		**Null Hypothesis: No linear relationship**		
Test Statistic	Value	Signif.	I(0)	I(1)
		Asymptotic: n=1000		
F-statistic	**4.984541**	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37
Actual Sample Size	28	Finite Sample: n=35		
		10%	2.46	3.46
		5%	2.947	4.088
		1%	4.093	5.532
		Finite Sample: n=30		
		10%	2.525	3.56
		5%	3.058	4.223
		1%	4.28	5.84

Based on the analysis of Case 3 results, we observe that the F statistic (Fs) has a value of 4.98, which exceeds the value (I1 = 3.49) at a significance level of 10%. As a result, we reject the hypothesis (H0), which suggests no cointegration, and instead accept the hypothesis (H1), indicating that there is cointegration among the variables studied. This holds for both term and long-term analyses.

To examine the equilibrium relationships between lnLCER, lnINF, and lnGFCF in the long term, we conducted an ARDL model test. The results of this analysis are provided in **Error! Reference source not found.**.

Tab. 8– Assessing Short and Long-Run Relationships between Variables. Source: own research.

Dependent Variable: D(LNFPI)				
Selected Model: ARDL(1, 0, 0, 1, 0)				
Case 2: Restricted Constant and No Trend				
Date: 04/18/26 Time: 18:26				
Sample: 1 32				
Included observations: 31				
Short-Run				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	-5.380768	0.656467	-8.196557	0.0000***

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LNFPI(-1)*	-0.518196	0.089769	-5.772577	0.0000***
LNINF**	-0.008041	0.011528	-0.697524	0.4922
LNLCER**	0.177021	0.026382	6.710027	0.0000***
LNGFCF(-1)	0.187808	0.038499	4.878296	0.0001***
LNEXCH**	0.105415	0.034003	3.100184	0.0049***
D(LNGFCF)	-0.081508	0.068104	-1.196806	0.2431
*** p-value incompatible with t-Bounds distribution.**				
Long run				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
LNINF	-0.015518	0.022689	-0.683932	0.5006
LNLCER	0.341611	0.083930	4.070170	0.0004***
LNGFCF	0.362427	0.027973	12.95623	0.0000***
LNEXCH	0.203427	0.047787	4.256919	0.0003***
C	-10.38366	1.069171	-9.711876	0.0000***
Final equation				
EC = LNFPI - (-0.0155*LNINF + 0.3416*LNLCER + 0.3624*LNGFCF +				
0.2034*LNEXCH -10.3837)				

Next come the findings of the test conducted to examine the relationship between the variable (lnFPI) and other independent variables, in both term and long-term contexts.

The error correction factor shows a negative sign and is statistically significant (prob=0.000<0.05). This suggests that there is a run equilibrium relationship (Winarno et al., 2021). Additionally, there is a mechanism to correct errors from run to run, with a correction factor of 0.518. This indicates that the series cannot deviate significantly from each other, and convergence is achieved in the run. The estimated value of the error correction factor is 0.518, which implies that 51.8% of adjustment speed occurs at a level of 1%. That is, the process itself is quite slow; It is about 46% a year (annual data). Besides, the variables representing food security in Algeria are explained with a total value of 74% at a confidence level of 1% (R-squared = 0.7326) (cf., **Error! Reference source not found.**).

The coefficient on LnLCER is positive in both the short and long run and statistically significant in the long run: a one-unit increase in LnLCER raises FPI by 0.177 units in the short run, and this contribution rises to 0.341 units in the long run. The result confirms the role of land under cereal production in food output (Barrios et al., 2008; Mahrous, 2019) and is consistent with the intuition that larger agricultural areas translate into higher productivity — provided a clear policy is in place to support and modernize the sector, and that complementary conditions, particularly labour and climate, are favourable. From a competitiveness perspective, the expansion of cultivated land enhances the supply capacity of the food sector and thereby strengthens its ability to compete with imports.

The inflation rate negatively affects FPI in the short and long run. This impact increases in the long run (from 0.008 to 0.015), as the rise in prices of raw materials intended for agriculture, such as fertilizers and seeds, especially imported ones, would reduce the opportunity to increase food production (Gazdar & Mallah, 2013), and therefore, the authorities must formulate an effective monetary policy to support food production in Algeria.

The negative sign on inflation in both the short and long run, although statistically insignificant, is consistent with weak pass-through from general inflation to food prices in Algeria. This pattern may reflect administered-price arrangements or subdued demand for staple food items,

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both of which help to keep food prices broadly stable and shape the way competitiveness operates within the food sector.

The empirical results for the Algerian economy point to a positive effect of gross fixed capital formation (GFCF) on the food price index: higher investment is accompanied by an increase in food prices. The most plausible reading is a demand-side mechanism. Higher capital formation reflects an expansion of economic activity and rising income levels; these in turn raise aggregate demand — and demand for food in particular — generating inflationary pressure that lifts the food price index. The finding is in line with Awuna et al. (2023) and von Cramon-Taubadel et al. (2009) for the Nigerian economy, where fixed capital formation also exerts a positive and significant effect on food prices through investment-driven growth in food demand. The result, therefore, supports the strand of the literature that treats capital formation as a driver of food inflation through the demand channel, while at the same time underlining the competitiveness challenge for Algeria: investment must be channeled towards expanding domestic food supply if it is not to translate primarily into upward pressure on prices.

Regarding LnEXCH, a positive relationship with FPI is found in both the short and long run, in line with Mazorodze (2026) and Gökçe (2021), who likewise document a positive and significant effect. The mechanism is straightforward: a depreciation of the dinar raises the local-currency cost of imported foodstuffs and intermediate inputs, which then feeds through to domestic food prices. For an import-dependent economy such as Algeria, this exchange-rate channel directly weakens the price competitiveness of locally available food, and consistent with what was stated in Rahman et al. (2023) in Pakistan, Imoughele and Ismaila (2017) in Nigeria, and Ibrahim (2015), where EXCH has a significant and serious harmful impact on food security in the long run. The instability of the exchange rate in Algeria has also increased the level of speculation due to the country's dependence on imported products, as imported goods compete with locally produced goods (Adekunle, n.d.).

4.6. Granger causality test

The Granger causality test is used to examine whether past values of one variable help to predict another, and so to disentangle the direction of influence among the variables of the model. As shown in Table 9, the probability values associated with the hypothesis that LNFPI Granger-causes each of the explanatory variables (LNINF, LNGFCF, LNEXCH) all exceed 0.05, indicating the absence of reverse causality from food prices to those determinants. The independent variables can therefore be treated as genuinely explanatory for LNFPI with no feedback effect, which provides additional support for the specification chosen in this study.

Tab. 9– Granger Causality Test. Source: own research.

Null Hypothesis:	**Obs**	**F-Statistic**	**Prob.**
LNINF does not Granger-cause LNFPI	30	0.21764	0.8059
LNFPI does not Granger-cause LNINF		**0.87243**	**0.4303**
LNLCER does not Granger-cause LNFPI	30	4.26527	0.0255
LNFPI does not Granger-cause LNLCER		**3.10883**	**0.0623**
LNGFCF does not Granger-cause LNFPI	30	3.24518	0.0559
LNFPI does not Granger-cause LNGFCF		**0.01652**	**0.9836**
LNEXCH does not Granger-cause LNFPI	30	1.04212	0.3675
LNFPI does not Granger-cause LNEXCH		**2.05561**	**0.1491**
LNLCER does not Granger Cause LNINF	30	0.88503	0.4252
LNINF does not Granger-cause LNLCER		0.03710	0.9636

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LNGFCF does not Granger-cause LNINF	30	0.39387	0.6786
LNINF does not Granger-cause LNGFCF		2.35525	0.1156
LNEXCH does not Granger-cause LNINF	30	1.99531	0.1570
LNINF does not Granger-cause LNEXCH		0.05570	0.9459
LNGFCF does not Granger-cause LNLCER	30	4.52039	0.0211
LNLCER does not Granger-cause LNGFCF		0.04765	0.9536
LNEXCH does not Granger-cause LNLCER	30	0.32768	0.7236
LNLCER does not Granger Cause LNEXCH		0.52200	0.5997
LNEXCH does not Granger-cause LNGFCF	30	1.10700	0.3462
LNGFCF does not Granger-cause LNEXCH		27.1871	5.E-07

The causal link running from fixed capital formation to food prices highlights the role of investment in strengthening competitiveness by expanding supply.

4.7. Model Diagnostic Tests

To evaluate the stability and security of the model, we conducted a series of tests:

4.7.1. AUTOCORRELATION TEST

The Durbin-Watson (DW) statistic is a measure that ranges from 0 to 4. **Error! Reference source not found.** presents a representation of how we can interpret the DW statistic. If the DW statistic falls between 0 and dl, it suggests the presence of serial autocorrelation. Values within the range dl to du and from 4 du to 4 dl do not provide evidence to determine whether there is a correlation or not. When the DW statistic is between 2 and 4, it implies that there is no correlation between errors, which supports the hypothesis that the errors are uncorrelated. Lastly, if the value falls between 4 dl and 4 it indicates a correlation, with a confidence level of 95%.

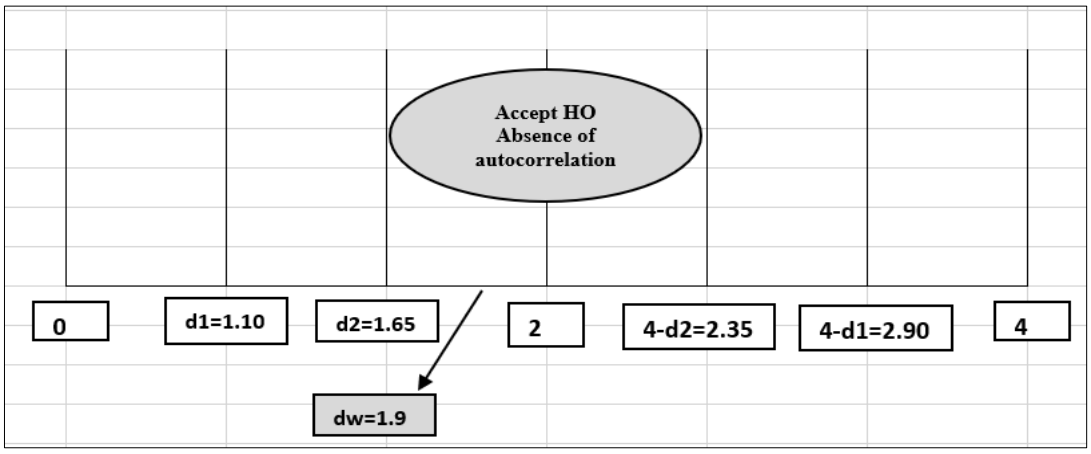

Figure 4- Durbin-Watson (DW) test for autocorrelation.
Source: Prepared by the researchers using Stata 17

From Figure 4, it is clear that the calculated value of dw = 1.90 is limited between du = 1.65 and 2; thus, it is in the range of accepting the null hypothesis HO, and accordingly, it can be said that the errors are not related to each other.

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4.7.2. BREUSCH–GODFREY LM TEST

To confirm the absence of error autocorrelation, the Breusch–Godfrey test was carried out for both first- and second-order serial correlation. This is one of the most widely used diagnostic procedures in econometric work and is employed to verify the temporal independence of the residuals, especially in dynamic specifications such as ARDL models, since it can detect serial correlation at different orders.

Tab. 10– The Breusch-Godfrey LM autocorrelation test. Source: own research.

Breusch-Godfrey Serial Correlation LM Test: (LAG=1)				
F-statistic	0.009812	Prob. F(1,23)		**0.9220**
Obs*R-squared	0.013219	Prob. Chi-Square (1)		**0.9085**
Breusch-Godfrey Serial Correlation LM Test: (LAG=2)				
F-statistic	0.079667	Prob. F(2,22)		**0.9237**
Obs*R-squared	0.222901	Prob. Chi-Square (2)		**0.8945**

The probability values associated with the Breusch–Godfrey LM statistic at both the first and the second order are above the 5% threshold. The null hypothesis of no autocorrelation in the residuals, therefore, cannot be rejected, indicating that the model is free of serial-correlation problems at either order.

4.7.3. BREUSCH-PAGAN TEST FOR HETEROSCEDASTICITY

The Breusch-Pagan / Cook-Weisberg tests are used to assess whether the error variances in a statistical model are equal (homoscedasticity) or if they vary based on a multiplicative function of one or more variables (heteroscedasticity).

Tab. 11– Heteroskedasticity Test: Breusch-Pagan-Godfrey. Source: own research.

F-statistic	**0.923228**	**Prob. F(6,24)**	**0.4959**
Obs*R-squared	5.813273	Prob. Chi-Square (6)	0.4444
Scaled explained SS	6.395353	Prob. Chi-Square (6)	0.3804

The heteroscedasticity test was carried out, and the probability values are above 0.05, which means that the error variance is constant. The model therefore shows no sign of heteroscedasticity, lending further statistical reliability to the estimates.

4.7.4. SKEWNESS AND KURTOSIS TESTS FOR NORMALITY

The Sktest provides information about the sample size (31 observations) and the probability of skewness (0.3564). It indicates that the distribution of skewness is asymptotically normal, as the P-value of skewness is greater than 0.05. Similarly, the probability of kurtosis (Pr (Kurtosis)) suggests that kurtosis follows a normal distribution as the sample size increases (with a p-value of kurtosis greater than 0.05).

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Tab. 12– Tests for normalcy using skewness and kurtosis. Source: own research.

Kurtosis and Skewness tests for normality					
----- Joint test -----					
Variable	Obs	Pr (kurtosis)	Pr (skewness)	Adj-chi2(2)	Prob >chi2
Resid	31	0.6247	0.3564	1.16	0.5595

The Prob>chi2 value of 0.5595 is greater than the significance level, which is set at 0.05 and represents a 5% threshold, indicating that we cannot reject the hypothesis. This means that the residuals align with a distribution.

4.7.5. CUSUM AND CUSUM OF SQUARED

For long-term economic relationships to hold true throughout time, an ARDL model must be stable. To find possible structural breaks in the coefficients or the variance of the residuals, researchers employ the CUSUM and CUSUMSQ tests. When the plotted statistics stay within the defined critical boundaries, it demonstrates that the model parameters are stable and reliable. If the lines cross these borders, it shows that a significant shift or policy change happened during the study period. Maintaining the precision and legitimacy of econometric analysis requires addressing such instability.

Although the Zivot–Andrews test points to a structural break in 2019 in the food price index series — reflecting a substantive change in its behavior — the CUSUM and CUSUM of squares tests show that the ARDL coefficients remain within the 5% confidence bands.

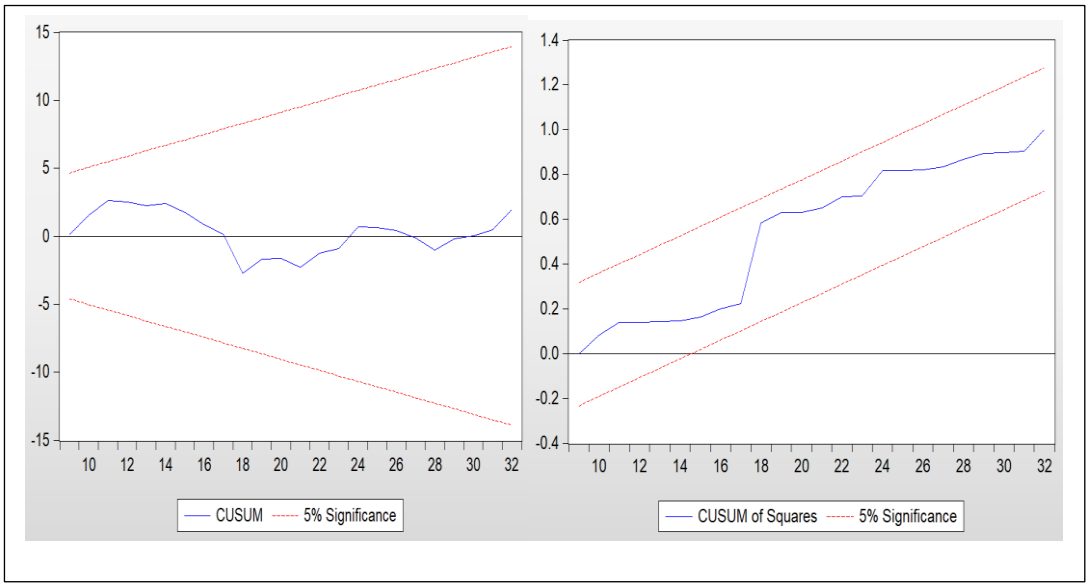

Figure 5- Cusum and Cusum of Squared Test.
Source: own research.

The CUSUM and CUSUM of squares tests demonstrate that the ARDL coefficients remain comfortably inside the 5% confidence ranges throughout the study period. Despite the Zivot-Andrews test's unambiguous identification of a structural break in the food price index series that occurred in 2019, this is especially significant. Such a discovery suggests that the price data's behavior during that particular year underwent a notable, sudden change. By successfully

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absorbing this structural break without sacrificing the overall estimation stability, the model preserves its predictive integrity, as seen in Figure 5. As a result, it is possible to view the 2019 shock as a singular occurrence that did not fundamentally change the underlying economic dynamics. Therefore, the long-run link between the analyzed variables remains robust and statistically sound despite this exogenous disruption. This robustness confirms that the model's parameters are not unduly sensitive to the reported volatility. In the end, the stability findings support the validity of the long-term inferences made from the empirical research.

5. CONCLUSION

This paper studies the determinants of food security (expressed by the Food Production Index (FPI)) in Algeria by conducting an analytical econometric study throughout 1990-2021 using the ARDL model, with a set of explanatory variables, namely, size of land under cereal production (hectares), inflation rate, exchange rate, and investment.

The results reveal a long-run equilibrium relationship between the variables. Land under cereal production exerts a positive and statistically significant effect on the food price index in both the short and long run; gross fixed capital formation also has a positive and significant effect; and the exchange rate enters with a positive and significant coefficient as well, reflecting the strong pass-through of currency depreciation to import-priced foodstuffs. Inflation carries a negative sign in both horizons but is statistically insignificant, consistent with weak transmission from headline inflation to food prices in Algeria. The model proves stable around an identified structural break in 2019.

Read through a competitiveness lens, these findings highlight three main transmission channels. The exchange-rate channel is the most direct: a depreciation of the dinar raises the local-currency cost of imported food and intermediate inputs, eroding the price competitiveness of food on the Algerian market. The investment channel works through GFCF: higher capital formation expands economic activity and household incomes, and — in the absence of an equivalent expansion in domestic food supply — translates partly into upward pressure on food prices through the demand channel. The supply channel works through cereal land: expanding the area under cereal production strengthens domestic supply and lessens the import dependence that has long weighed on the competitiveness of Algeria's food sector. Inflation's weak short- and long-run effect, finally, suggests that food-price stability in Algeria is shaped less by general price dynamics than by structural factors specific to the food sector.

Therefore, this study first recommends the necessity of adopting several strategies for reducing food price inflation in Algeria. The government should adjust the exchange rate stabilization policy, which will help enterprises and individuals increase investment, which in turn will reduce imports and thus reduce food price inflation in the country. The Algerian authorities must formulate an effective monetary policy in order to support food production and confront inflation that threatens food security in the country. For this, and to avoid food security risks resulting primarily from the inability of exports to cover imports, Algeria must pay increasing attention to promoting its exports on the one hand, and on the other hand, creating a strong local production capable of compensating the import process, qualitatively and quantitatively, and further, paying attention to the agricultural sector, especially productive lands, to achieve economic diversification and food security.

This type of analysis has some limitations, especially since it does not take into account all the variables that affect food security, such as rainfall amount, temperature, climate change, food

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exports (as a proportion of total exports), food imports (as a proportion of total imports), labor force (in the agricultural sector), etc. In this connection, including such variables with a longer study period and an appropriate standard model would be of great importance to have more appropriate and clearer results, as well as positive effects in helping policymakers make the right decisions to reduce the problem of food security in Algeria. The same case study would also be of great importance for the countries, the economies of which are similar to that of Algeria. Taken together, the findings of this study indicate that strengthening competitiveness in Algeria's food sector requires sustained agricultural investment, effective control of inflation, and clear gains in resource-use efficiency, all of which together support stable food prices.

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REFERENCES

1. Adekunle, k. (n.d.). *Exchange rates and the consumer price index in Nigeria: A causality approach*. https://hdl.handle.net/10520/EJC133837
2. Aidoo, R., Mensah, J. O., & Tuffour, T. (2013). Determinants of household food security in the Sekyere-Afram Plains District of Ghana. *European Scientific Journal*, *9*(21). https://doi.org/10.19044/esj.2013.v9n21p%p
3. Aker, J., Aker, J., & Lemtouni, A. (1999). Framework for assessing food security in the face of globalization: The case of Morocco. *Agroalimentaria*, *5*(8). https://dialnet.unirioja.es/descarga/articulo/3229431.pdf
4. Amaza, P. S., Adejobi, A. O., & Fregene, T. (2008). Measurement and determinants of food insecurity in northeast Nigeria: Some empirical policy guidelines. *Journal of Food, Agriculture and Environment*, *6*(2), 92–96. https://hdl.handle.net/10568/90859
5. Applanaidu, S. D., Bakar, N. A., & Baharudin, A. H. (2014). An econometric analysis of food security and related macroeconomic variables in Malaysia: A vector autoregressive approach (VAR). *UMK Procedia*, *1*, 93–102. https://doi.org/10.1016/j.umkpro.2014.07.012
6. Awuna, J. M., Musa, A. U., & Onah, A. E. (2023). Effects of gross fixed capital formation and selected international trade policy instruments on agricultural productivity in Nigeria: An autoregressive distributed lag (ARDL) model approach. *Nigerian Journal of Agriculture and Agricultural Technology*, *3*(2), 1–9. https://doi.org/10.59331/njaat.v3i2.536
7. Barrios, S., Ouattara, B., & Strobl, E. (2008). The impact of climate change on agricultural production: Is it different for Africa? *Food Policy*, *33*(4), 287–298. https://doi.org/10.1016/j.foodpol.2008.01.003
8. Bloem, J. R., & Farris, J. (2022). The COVID-19 pandemic and food security in low- and middle-income countries: A review. *Agriculture and Food Security*, *11*(1), 55. https://doi.org/10.1186/s40066-022-00391-4
9. Butzer, R., Larson, D. F., & Mundlak, Y. (2010). Measures of fixed capital in agriculture. Policy research working paper 5472. https://short-url.cc/1sT-m
10. Ceesay, E. K., & Ben Omar Ndiaye, M. (2022). Climate change, food security, and economic growth nexus in the Gambia: Evidence from an econometric analysis. *Research in Globalization*, *5*, 100089. https://doi.org/10.1016/j.resglo.2022.100089
11. FAO publications catalogue 2022. (2022). https://doi.org/10.4060/cc2323en

https://doi.org/10.7441/joc.2026.02.06

12. *Food production index (2014-2016 = 100) - Algeria | data*. (n.d.). https://short-url.cc/1ypgr
13. Gazdar, H., & Mallah, H. B. (2013). Inflation and food security in Pakistan: Impact and coping strategies. *IDS Bulletin*, *44*(3), 31–37. https://doi.org/10.1111/1759-5436.12028
14. Gebre, g. G. (2012). Determinants of food insecurity among households in Addis Ababa City, Ethiopia. *Interdisciplinary Description of Complex Systems*, *10*(2), 159–173. https://doi.org/10.7906/indecs.10.2.9
15. Gökçe, C. (2021). Asymmetric effect of oil price and exchange rate on food prices: The case of Turkey (Petrol fiyatı ve döviz kurunun gıda fiyatları üzerine asimetrik etkisi: Türkiye örneği). *Business and Economics Research Journal*, *12*(3), 599–611. https://doi.org/10.20409/berj.2021.340
16. Ibrahim, M. H. (2015). Oil and food prices in Malaysia: A nonlinear ARDL analysis. Agricultural and Food Economics, *3*(1), 1–14. https://doi.org/10.1186/s40100-014-0020-3
17. Imoughele, L. E., & Ismaila, M. (2017). Impact of exchange rate on non-oil exports. *International Journal of Academic Research in Accounting, Finance and Management Sciences*, *5*(1), 254–265. https://dx.doi.org/10.6007/IJARAFMS/v5-i1/1556
18. Jeder, H., Hattab, S., & Frija, I. (2020). An econometric analysis for food security in Tunisia. *Mediterranean Journal of Economics, Agriculture and Environment*, *19*(4), 3–14. https://short-url.cc/1ypgA
19. Khalifa, J. (2025). The impacts of climate change, agricultural productivity, and food security on economic growth in Tunisia: Evidence from an econometrics analysis. *Research on World Agricultural Economy*, *6*(1), 1–18. https://doi.org/10.36956/rwae.v6i1.1457
20. Mahrous, W. (2019). Climate change and food security in each region: A panel data analysis. *Review of Economics and Political Science*, *4*(4), 270–284. https://doi.org/10.1108/REPS-12-2018-0039
21. Mazorodze, B. T. (2026). Exchange rate pass-through to food prices in South Africa. *Cogent Food & Agriculture*, *12*(1), 2626602. https://doi.org/10.1080/23311932.2026.2626602
22. Mohamed, G., et al. (2024). Identifying determinants of food security using panel data analysis: Evidence from Maghreb countries. *Economies*, *12*(4), 91. https://doi.org/10.3390/economies12040091
23. Oke, M. A. (2015). Determinants of national food security in Nigeria. *Journal of Economics and Sustainable Development*, *6*(9). https://short-url.cc/1sU1j
24. Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*(3), 289–326. https://doi.org/10.1002/jae.616
25. Rahman, I. U., Ali, W., Khattak, N., & Khan, J. (2023). Vulnerability of food security in the presence of a deteriorating exchange rate regime in Pakistan. *Journal of Applied Economics and Business Studies*, *7*(2), 65–78. https://short-url.cc/1sU2Q
26. Samal, A., Ummalla, M., & Goyari, P. (2022). The impact of macroeconomic factors on food price inflation: Evidence from India. *Future Business Journal*, *8*(1). https://doi.org/10.1186/s43093-022-00127-7
27. von Cramon-Taubadel, S., Anriquez, G. de Haen, H., & Nivyevskiy, O. (2009). *Investment in developing countries' food and agriculture: assessing agricultural capital stocks and their impact on productivity*. https://openknowledge.fao.org/handle/20.500.14283/ak975e

https://doi.org/10.7441/joc.2026.02.06

28. Winarno, S., et al. (2021). Application of the vector error correction model (VECM) and impulse response function for daily stock prices. *Journal of Physics: Conference Series*, *1751*(1), 012016. https://doi.org/10.1088/1742-6596/1751/1/012016

Contact information :

Dekkiche Djamal, PH.D.
Oran Graduate School of Economics, Algeria
e-mail: djamal.dekkiche@ese-oran.dz, dekkiche27@hotmail.fr
https://orcid.org/0000-0002-1463-4413

Khelifa Hadj, PH.D.
University of Mostaganem, Faculty of Economics, Algeria
e-mail: hadj.khelifa@univ-mosta.dz
https://orcid.org/0000-0002-3303-122

Laila Oulad Brahim, PH.D.
University of Ghardaia, Faculty of Economics, Ghardaia, Algeria
e-mail: ouladbrahim.laila@univ-ghardaia.dz
https://orcid.org/0009-0008-6259-4840

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