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The impact of the food industry on economic growth in Algeria during the period 2005-2022 A comprehensive Study using the Bootstrapping ARDL "BARDL"

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Abstract

This study aims to elucidate the impact of the food industry on economic growth during the period from 2005 to 2022 in Algeria, using the simultaneous integration test in small samples and the Bootstrapping ARDL model(BARDL). The results of the empirical study reveal a long-term equilibrium relationship between economic growth, the food industry, and exports from the food industry. To correct deviations, it requires a speed of 0.91%, equivalent to approximately two years. The study also demonstrates that the food industry significantly influences economic growth, as represented by the Gross Domestic Product

Keyword:Food industry, Long-term relationship, Bootstrapping, Saturation index

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1. INTRODUCTION

The development of the food industry is considered one of the strategies for économico diversification. The food industry holds significant importance in the industrial structure due to its weight in harnessing natural resources, leveraging agricultural products, increasing national income, and reducing imports. Therefore, Algeria aims to break away from oil dependence and shift towards productive investment. The food industry plays a crucial role in achieving self-sufficiency, food security, and exporting non-oil surplus products to European and African markets, generating financial returns in the process.

Problem Statement: What is the impact of the food industry on economic growth in Algeria?

1.1 Research Questions:

-To what extent does the food industry contribute to the Gross Domestic Product?

-Is the Food industrie considered an alternative to pétroleur in the Algérien économie?

-What is the nature of the equilibrium relationship between economic growth and the food industry?

1.2 Research Hypotheses:

-The low contribution of the food industry hampers the acceleration of economic growth.

-The food industry falls short as a substitute for the oil sector in Algeria.

-There exists a long-term equilibrium relationship between economic growth and the food industry.

2. The Reality of the Food Industry in Algeria during 2005-2022:

The food industry sector is crucial in the national economy as one of the fundamental branches of the manufacturing sector. This is attributed to its flexibility in production due to the availability of raw materials, mainly agricultural products.

2.1 Définition of the Food Industry and Various Food Products and their Development Stages:

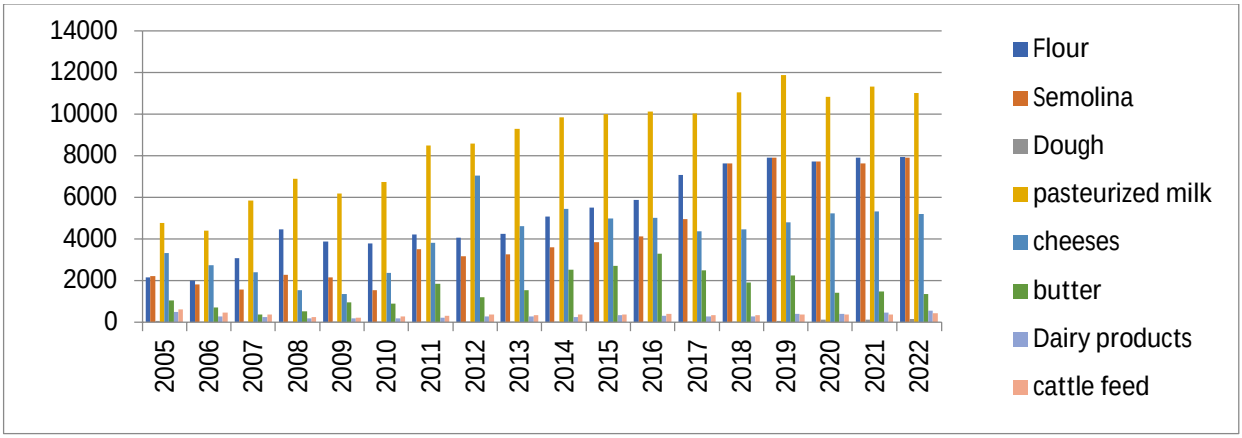
The food industry is the sector that transforms agricultural raw materials into consumable products with a longer shelf life and greater utility. This includes the production of oils, flour, bread, pastries, sugar, dairy products, dried fruits, and fish

preservation industries, among others. These are food industries associated with other crafts such as grain cultivation (Kenya, 2013, p. 64).

Some define it as an "industrial branch that transforms agricultural raw materials according to specified standards." These industries work to keep food products usable for the longest possible period through processing, preservation, and canning methods in line with good consumer conditions (Made, 2016, p. 8).

The food industry is considered a branch of the manufacturing sector, encompassing a variety of categories and types as illustrated in the following figure

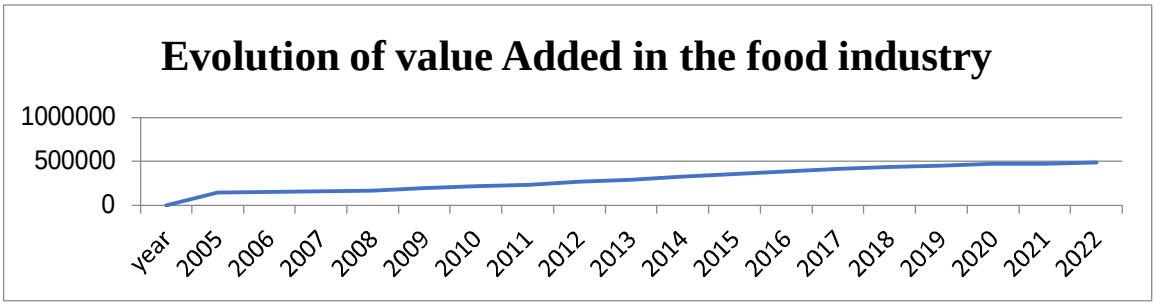
Figure 01: Varions Types of Food Product During the Période 2005-2022



Source:Compiled by researchers based on data provided by the National Statistics Office.

Through graphical representation, it is evident that pasteurized milk represents the largest production share, accounting for 33.39%, followed by flour at 21.74%, semolina at 19.13%, and cheeses at 16.23%. On the other hand, products such as pastries, butter, and ghee, milk derivatives, and cattle feed have significantly lower percentages, amounting to 0.23%, 6.08%, 1.32%, and 1.82% respectively.

Figure 02: Evolution of Food Industry Production in Algeria During the Period 2005-2022 (Million DZD)



Source: Compiled by researchers based on data provided by the National Statistics Office

The production of the food industry has shown a gradual and continuous increase

since 2005 until 2022, experiencing a growth from 2.5% in 2005 to 8.8% in 2022. This growth can be attributed to the development programs implemented by Algeria from 2010 to 2022, particularly the National Program for the Promotion of Investment in the Food Industry, as well as youth employment programs like ANSEJ and CNAC. Additionally, modifications to investment laws, economic openness, and privatization have contributed to this positive trend.

2.2-The Contribution of the Food Industry to the Gross Domestic Product and Exports During the Period 2005-2022

The food industry in algeria contribution to several sectors including the gross domestic product (GDP) and export

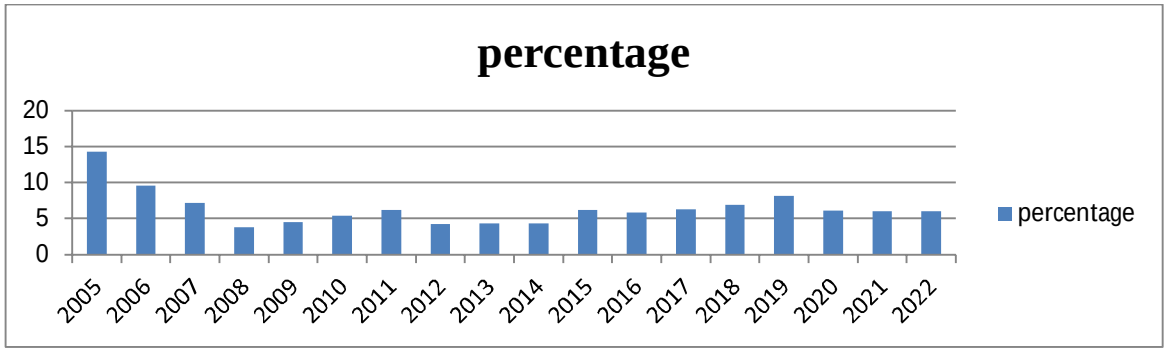
Table 01: Contribution of the Food Industry to the Gross Domestic Product During the Period 2005-2022

Year	%	years	%	year	%	year	%	year	%	year	%
2005	1.83	**2006**	1.71	**2007**	1.66	**2008**	1.48	**2009**	1.89	**2010**	1.7
2011	1.58	**2012**	1.64	**2013**	1.71	**2014**	1.89	**2015**	2.13	**2016**	2.17
2017	2.15	**2018**	2.12	**2019**	2.16	**2020**	2.51	**2021**	2.13	**2022**	2.35

Source: Compiled by researchers based on data provided by the National Statistics Office.

Through the table, we observe that the contribution percentage of the food industry to the Gross Domestic Product remained relatively stable and low throughout the period 2005-2022, ranging from approximately 1.5% to 2%. The highest value was recorded in 2020 at 2.51%. However, from 2005 to 2014, the contribution percentage of the food industry declined due to the increase in the contribution of fuels to the gross output resulting from rising oil prices. Afterward, the contribution percentage remained stable until 2022.

Figure 03: Contribution of Food Industry Exports to Non-Fuel Exports from 2005 to 2022



Source: Compiled by researchers based on data provided by the National Statistics Office

Through graphical representation, it is observed that the contribution of food exports to total non-fuel exports fluctuates between increases and decreases during the period 2005-2022. In 2005, its contribution was 14.3%, experiencing a sudden decrease to 9%. This decline continues until 2022 due to the state's lack of focus on economic diversification outside the hydrocarbon sector, despite efforts by the Ministry of Trade to promote non-fuel exports.

3. Importance of the Food Industry and its Challenges:

The food industry assumes significants importatnce in the algeria economy ,given its role in accelerating economic growth , in addition to its capability to contributed to the accumulation of capital.

3.1 Importance of the Food Industry:

-The food industry is a crucial and essential sector as it serves as a fundamental link between agriculture and manufacturing. The continuity of food processing is closely related to the abundance of specific food resources and can be summarized as follows:

-Food industries play a vital role in preserving perishable foods, ensuring their availability throughout the year, and facilitating their global marketing and distribution.

-The food industry, as a transformative industry, holds a prominent position in terms of labor intensity, aiding densely populated countries in absorbing unemployment.

-It contributes to finding new food sources, such as using microorganisms to manufacture certain food products and producing high-nutrient-value foods. This allows for the production of healthy, toxin-free, and pollution-free foods, including specialized foods for children and patients, such as sugar-free and low-fat foods.

-Manufactured food prices are relatively inexpensive compared to their value, considering the costs of transportation, processing, and distribution. Advances in this field have led to the innovation of various types of foods.

-The food industry contributes to raising living standards, increasing individual and societal consumption and purchasing power, and encouraging investment to achieve maximum self-sufficiency, providing hard currency to the national economy (Wahab, 2017, p. 9).

3.2-The food industry sector in Algeria, like other sectors, faces several obstacles, including

-Weak Interconnection between the Food Industry and Agriculture: Agricultural contribution to the development of the food industry and its supply of necessary

materials for production is significant. However, this integrative relationship is very weak in Algeria due to slow growth and production.

-Weak Agricultural Investment in Algeria: Limited agricultural production can be attributed to the failure of the adopted agricultural policy and insufficient investment in the agricultural sector. Statistics from the National Agency for Investment Development (ANDI) indicate low rates of investment in agriculture.

-Effectiveness of Research and Development: Despite the importance of development operations in increasing competitiveness and productivity in various industries, including the agricultural sector, this field remains marginalized due to a lack of attention, expertise, and distance from research centers.

-Strong Foreign Competition: The heavy reliance on exports as the primary source to supply the local economy with food products has made food dependency one of the major challenges in the Algerian economy. Most Algerian food institutions lack the capabilities to maintain their shares in global markets (Ferhat, 2016, p. 256).

4- EXPERIMENTAL *:* Standardized Education Academy - Case Study of Algeria during the période 2005-2022.

Studying the Relationship Between the Output of the Food Industry and the Exports of the Food Industry with Economic Growth in Algeria for the Period 2005-2022 Using the Bootstrap ARDL Model as one of the modern models, applied through R programming.

4.1-Definition of the Model Used

In 2001, Shin and Smith, along with Pesaran, published their renowned research on the Autoregressive Distributed Lag (ARDL) approach to testing bounds for cointegration. What distinguishes this model is its departure from the constraints of traditional modeling of common integration, which imposes the condition of common integration of the same order, provided that these series are not integrated of the second order and are neither seasonal nor explosive. The ARDL model relies on bound testing to determine the existence of a long-term equilibrium relationship through the F Bound Test and tests the significance of the dependent variable to ascertain the existence of a long-term relationship through the T Bound Test.

The ARDL model has undergone development since its introduction, where the critical values presented were specifically reliant on large samples, leading to criticism from researchers. Subsequently, Narayan (2004) derived and developed critical values for smaller sample sizes, defined as 30 samples or more. However, for series with small sample sizes (less than 30 observations), an exception remained due to the impracticality of conducting bound tests to determine the existence of a long-

term equilibrium relationship, given the unavailability of critical values for such cases. With the evolution of programming and the emergence of various software tools, the critical values for small samples have been made available using the Bootstrapping technique (McNown, 2017). This technique addresses statistical problems, a feature readily available in R programming.

Our study relies on this approach, utilizing a small sample size of 18 observations while maintaining the same conditions and assumptions that underlie the ARDL model, which are as follows:

- The dependent variable should be stationary at the first difference, and the independent variables should be stationary at the first difference or a combination of level and first difference, without exceeding stationarity to the second difference.
- Independent variables should genuinely be external variables, meaning they affect the dependent variable without being influenced by it, indicating a one-way causal relationship.
- Time series should not be seasonal or explosive (Pesaran, 2001).

4.2.-Application of the Bootstrap ARDL Model

The application of the Autoregressive Distributed Lag (ARDL) model with distributed and lagged time gaps requires certain assumptions in the study data. This involves determining the degree of stationarity using the Bootstrap Unit Root test. Subsequently, we identify the optimal lag length that helps us obtain the most suitable model for estimation. We then verify the efficiency and accuracy of the estimation by ensuring that the model is free from various standard problems. Afterward, we delve into the underlying philosophy of the model, which revolves around testing the existence of a long-term equilibrium relationship (Bounds Test).

4.3.-Nature of Variables and Symbols Used for Representation

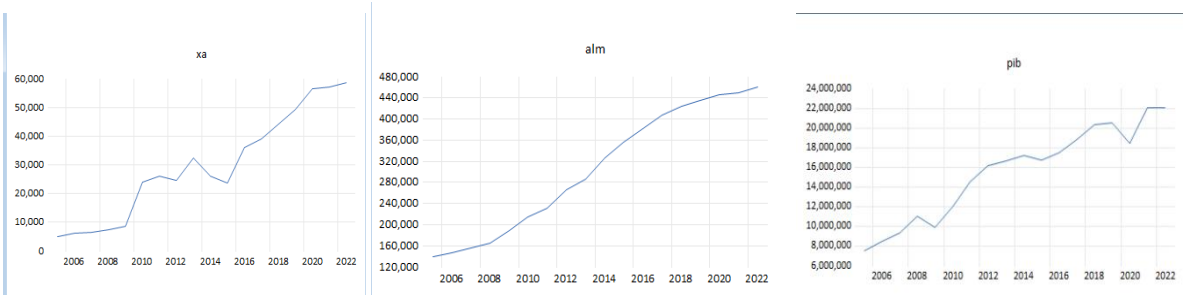
PIB :The dependent variable represents the Gross Domestic Product (GDP) in million DZD, with data provided by the World Bank (PIB).

ALM: The independent variable represents the output from the food industry in million DZD, with data provided by the National Statistics Office

XA: The independent variable represents exports from the food industry in million DZD, with data provided by the National Statistics Office.

Descriptive Analysis of Study Variables

Figure (04): Graphic Representation of Study Variables



"The Source: Compiled by researchers using Eviews 13

Through the above figure related to the economic variables under study, it becomes evident that all variables exhibit a general and consistent trend. They show a substantial and accelerating increase throughout the study period (2005-2022).

- **Descriptive Characteristics of Study Variables**

Table (02): Descriptive Characteristics of Variables

variables	ALM	PIB	XA
Mean	304308.9	15540000	29502.45
Median	306031	16680000	26107.65
Maximun	460800	22080000	58665
Mininum	138391	7560000	5027.7
Std.Dev	118708.5	4725374	18482.55
Skewness	-0.067726	-0.303939	0.167122
Kurtosis	1.452149	1.818275	1.828368
Jarque.Bera	1.810643	1.324492	1.113330
Probabilité	0.404412	0.515692	0.573117
sum	5477561	2.80^{E}+0.8	531044.1
Sum sq.Dev	2.40^{E}+11	3.80^{E}+14	5.81^{E}+0.9
Observation	18	18	18

The Source: Compiled by researchers using Eviews 13 software

From the above figure, we observe that the study variables PIB, ALM, and XA follow a normal distribution, as indicated by the Jarque–Bera test. The statistical probability for this test is greater than 0.05 for each variable. Additionally, the skewness coefficient is less than 3, indicating that all variables are negatively skewed. The kurtosis coefficient suggests that ALM and PIB are platykurtic, leaning towards the left, while variable XA is leptokurtic, leaning towards the right.

- **Saturation Indicator Test**: Detecting Outliers and Structural Changes The saturation indicator serves as a methodology for identifying outliers and structural changes in time series within the model. It is applied using Eviews 13 software and consists of the following elements (Martyna Marczak, 2016, p5):

- ✓ **Impulse Indicators**: Detecting outliers.
- ✓ **Step Indicator**: Identifying structural changes.
- ✓ **Trend Indicature**: Detecting structural changes in the general trend

Table (03): Saturation Indicator Test Résulta

Dependent Variable: PIB
Method: Least Squares
Date: 09/22/23 Time: 19:21
Sample: 2005 2022
Included observations: 18
Indicator Saturation: IIS SIS TIS, 51 indicators searched over 2 blocks
No indicators detected

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	4818350.	1205378.	3.997375	0.0012
ALM	29.29967	8.474881	3.457237	0.0035
XA	61.19823	54.43190	1.124308	0.2786

R-squared	0.933881	Mean dependent var	15540000
Adjusted R-squared	0.925066	S.D. dependent var	4725347.
S.E. of regression	1293524.	Akaike info criterion	31.13465
Sum squared resid	2.51E+13	Schwarz criterion	31.28305
Log likelihood	-277.2119	Hannan-Quinn criter.	31.15511
F-statistic	105.9324	Durbin-Watson stat	1.331326
Prob(F-statistic)	0.000000		

The Source: Compiled by researchers using Eviews 13 software

Through this test, the saturation indicator revealed the absence of outliers and structural changes, indicating that the model is free from structural breaks and unusual points. The table outputs did not include @speriouse (indicating no outliers) and did not include @after (indicating no structural changes in the general trend) and @trend. The outputs of this test only included variable coefficients.

- **Stability Analysis**

We consider time series to be stable if they do not contain a unit root. One of the prominent tests for detecting the presence or absence of a unit root in small samples is the Bootstrap unit root test, as outlined by Robert (2008, pp43-71).

The null hypothesis

(H0) :is that the series is unstable and contains a unit root, while the alternative hypothesis

(H1) :is that the series is stable and does not contain a unit root

Table (04): Stability Results of Variables Using Bootstrap ADF

variables	At the level		At the first difference	
	probabilité	Décision	Probabilité	Décision
PIB	0.5778	unstable	0.00	stable
ALM	0.005	stable		
XA	0.554	unstable	0.001	unstable

The Source: Compiled by researchers using R software.

The determination of the stability of time series relies on both the statistical value and its comparison with the critical value, or reliance on the statistical p-value. When the significance is less than 0.05, we conclude that the series is stable, accepting the alternative hypothesis and rejecting the null hypothesis, and vice versa.

Based on the presented results, indicating the stability of the series at the level and first difference in the presence of a constant and a general trend, it is evident that both PIB and XA are stable at the first difference I(1), while ALM is stable at the level I(0).

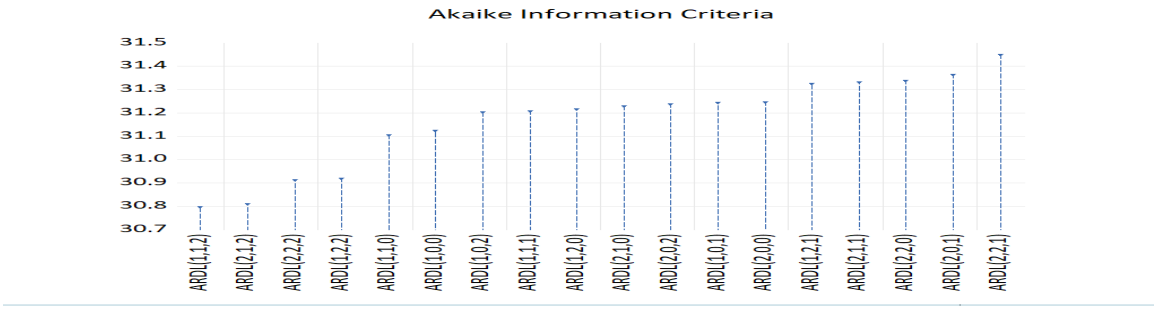
Since the ARDL model assumes that the series should be stable at the first difference I(1) or a combination of level and first difference I(1), I(0), the basic conditions for stability in the ARDL model have been fulfilled:

- ✓ The dépendent variable is stable at the first différence.
- ✓ The Independent variables are stable at both the level and the first différence.

- **Determining Lag Periods**

Before specifying the ARDL model, it is essential to determine the optimal lags for the study variables. This is crucial for obtaining the optimal model for estimation with appropriate lag gaps. In this regard, we will rely on the lag order selection test using the Akaike Information Criterion (AIC)

Figure (05): Optimal Lag Selection



The Source: Compiled by researchers using Eviews 13 software

Based on the graphical representation, it is evident that the optimal lag order according to the AIC criterion is (1,1,2).

After conducting both the stability test and the lag order selection test aligned with the study model, we proceed with obtaining the optimal ARDL model for our study.

Table (05): Illustrates the process of obtaining the optimal ARDL model at the optimal lag order

```
Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  6.494e+06  1.594e+06   4.075  0.00278 **
L(pib, 1)    2.640e-02  2.737e-01   0.096  0.92526
xa           8.917e+00  6.175e+01   0.144  0.88836
L(xa, 1)     1.642e+02  6.691e+01   2.455  0.03648 *
alm          1.898e+01  3.742e+01   0.507  0.62425
L(alm, 1)    5.569e+01  5.862e+01   0.950  0.36689
L(alm, 2)   -6.537e+01  3.470e+01  -1.884  0.09222 .
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
```

The Source: Compiled by researchers using R software

From the graphical representation, we observe that the most suitable estimated model is ARDL (1,1,2), as presented in the figure. The dependent variable, representing Gross Domestic Product, is lagged by one period. As for the independent variables, the output of the food industry is lagged by one period, and exports from the food industry are lagged by two periods.

- **Model Validity Tests**

It is necessary to conduct tests to verify the validity of the model, and among these tests

Table (04): Summary of Diagnostic Tests

Type the test	test	Statistical Value	Probability value
Distribution of Residues	**Jarque-Bera**	2.16	0.33
autocorrelation	**LM-Correlation**	0.9	0.44
Heteroscedasticity	**Breush pagan godfrey**	0.33	0.9
Spécifications	**Ramsey**	-0.54	0.59

The Source: Compiled by researchers using Eviews 13 software

The tests shown in the above table are based on similar assumptions in principle. The null hypothesis for these tests assumes the absence of a problem, while the alternative theory suggests the opposite. From the table above, we observe that the p-values for tests such as Jarque–Bera, Breusch–Godfrey, and serial correlation are significantly greater than the critical values (0.05). This indicates that we accept

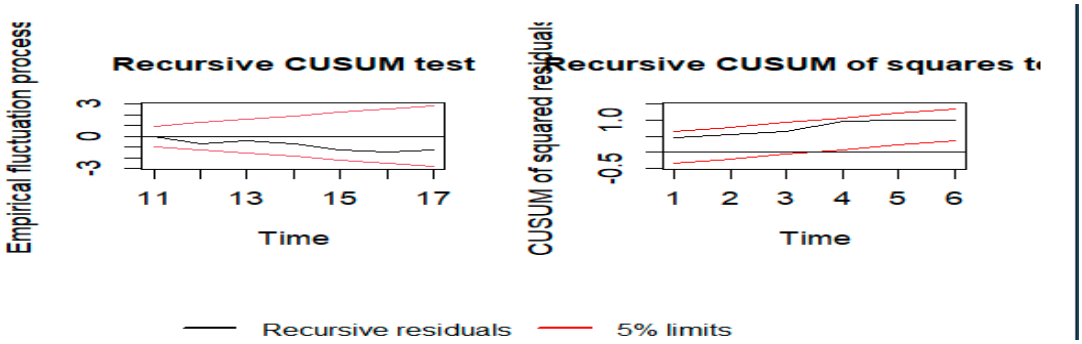
the null hypothesis for all tests. Therefore, the model estimation does not suffer from the problems of autocorrelation, heteroscedasticity, and follows a normal distribution.

Additionally, the Ramsey test notes that the probability corresponding to the F-statistic is greater than 0.05 at a significance level of 5%. Therefore, we accept the null hypothesis, suggesting that the model is well-specified.

- **Structural stability tests for the model, CUSUM and CUSUM OF SQUARE**

To ensure the model's freedom from structural changes and the coherence and stability of long-term parameters with short-term parameters, we use the Cusum and Cusum of Squares test, which relates to the cumulative sum behavior of residuals proposed by Brown (Brown, 1975, p149).

Figure (07): CUSUM OF SQUARES and CUSUM Tests for Structural Stability

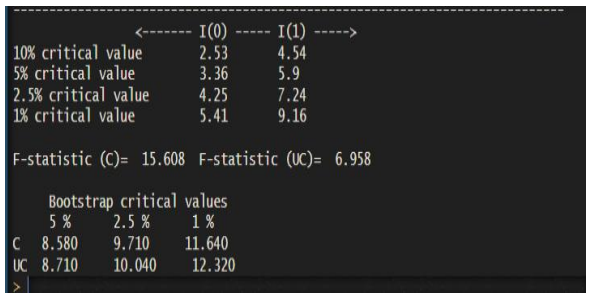


Source: Prepared by researchers using the R

Through the figure, we observe that the cumulative sum of residuals (CUSUM) moves within the 5% significance bounds. This indicates that the model is initially structurally stable, and there is coherence between short-term and long-term relationships.

Long-Term Equilibrium Bound Tests (F-BOUND TEST, T BOUND TEST): As mentioned earlier, due to the small sample size (less than 30 observations), it remains an exception, making it impractical to conduct long-term equilibrium bound tests to determine the presence of a long-term equilibrium relationship. Therefore, we relied on programming and simulation methods to derive critical values using the Bootstrapping simulation technique, which is now available in the R programming language through the "Bootsrapping ARDL" package. This approach was employed to determine the existence of a long-term equilibrium relationship during the study period from 2005 to 2022.

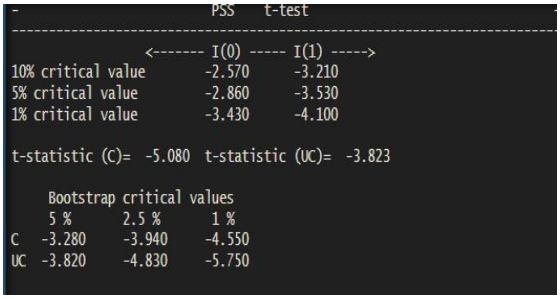
Table No (08): T Bounds Test – F Bounds Test



```
                <------- I(0) ----- I(1) ----->
10% critical value        2.53       4.54
5% critical value         3.36       5.9
2.5% critical value       4.25       7.24
1% critical value         5.41       9.16

F-statistic (C)=  15.608  F-statistic (UC)=  6.958

     Bootstrap critical values
     5 %      2.5 %     1 %
C   8.580     9.710     11.640
UC  8.710     10.040    12.320
```



```
                                PSS    t-test
-----------------------------------------------------------------------------
                <------- I(0) ----- I(1) ----->
10% critical value        -2.570     -3.210
5% critical value         -2.860     -3.530
1% critical value         -3.430     -4.100

t-statistic (C)=  -5.080  t-statistic (UC)=  -3.823

     Bootstrap critical values
     5 %      2.5 %     1 %
C   -3.280    -3.940    -4.550
UC  -3.820    -4.830    -5.750
```

Source: Prepared by researchers using the R

Through the figure, the critical values generated using the simulation method for the study sample are shown. The assumed critical values at 5%, estimated at 8.58, are lower than the calculated F value, which is 15.608. Consequently, it can be concluded that there is a possibility of a long-term equilibrium relationship. Additionally, the generated T value, representing the T Bounds Test for the estimated model, is greater than the assumed critical values at 5%, set at 3.2. Although it is smaller than the absolute value of the calculated T value (5.08), the existence of a long-term equilibrium relationship holds economic significance. As the long-term relationship is confirmed, correctionsfor deviations are made using the error correction coefficient. This coefficient allows us to rectify short-term deviations to achieve equilibrium in the long term.

- **Error Correction Model ECM**

After confirming the existence of a cointegrating relationship through boundary tests such as the F bound test and T bound test, we proceed to estimate the short-term relationship using the Error Correction Model (ECM). The ECM is employed to rectify errors by capturing the pull towards equilibrium, considering the negative and meaningful sign. Furthermore, we will estimate the long-term relationship associated with the mode.

Table 09: Represents the Error Correction Model (ECM) Test"

Model ARDL(1.1.2)

variable	coeifficient	Std error	Statistique	Prob
Cointeq*	-0.917543	0.209178	-4.386415	0.0011
D(xa)	8.005873	45.87754	0.174505	0.8646
D(ALM)	19.07145	30.36644	0.628044	0.5428
D(ALM(-1))	74.29364	26.17591	2.838245	0.0161
C	6336039	1349912	4.693668	0.0007

The Source: Compiled by researchers using Eviews 13 software

From the presented figure, which represents the Error Correction Model (ECM) table, it is evident that the error correction coefficient assumes a negative and statistically significant value. This signifies the presence of a short-term equilibrium relationship among the study variables, pointing towards long-term equilibrium. The coefficient operates to swiftly correct deviations at a rate of approximately 0.91%. This implies a time period estimated at (1/0.91), or roughly two years, to attain long-term equilibrium.

5. RESULTS AND DISCUSSION

Through our empirical study of Algeria's case during the period 2005-2022 to examine the impact of the food industry on economic growth, we arrived at the following results:

- Through graphical representation of time series, it is observed that all variables exhibit a general and constant trend.
- The dependent variable and the independent variable (XA, PIB) show stationarity at the first difference, indicating that both series are integrated of order I(1), while the independent variable ALM is stationary at level I(0).
- Existence of a long-term equilibrium relationship among the study variables PIB, XA, ALM.
- To correct deviations and reach long-term equilibrium requires a correction rate of 1.09, approximately two years. This suggests that correcting deviations necessitates a lengthy period, reflecting the inflexibility of the production system in the food industry sector.

6. CONCLUSION

The topic of the food industry in Algeria holds significant importance due to its capabilities and resources, allowing it to contribute substantially to capital accumulation and productivity growth. In this paper, we addressed the impact of the food industry on economic growth in Algeria during the period 2005-2022. To achieve this purpose, we relied on econometric analysis using the Bootstrap ARDL (AutoRegressive Distributed Lag) model to quantify it for small sample sizes. The results obtained in the study and the statistical tests conducted allow us to address the posed problem, which revolves around

The food industry in Algeria does not significantly impact economic growth, explaining the weakness of this industry in contributing to growth in Algeria, thus confirming the validity of the first hypothesis.

Additionally, the Algerian economy still primarily relies on the hydrocarbons sector. The food industry has not played a role in achieving diversification in exports, affirming the validity of the second hypothesis.

There exists a long-term equilibrium relationship between economic growth, output from the food industry, and exports from the food industry, confirming the validity of the third hypothesis.

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Bootstrap unit Root test

```
> boot_adf(pib)
Progress: |----------|
          **********

        AWB bootstrap OLS test (with intercept) on a single time series

data: pib
null hypothesis: Series has a unit root
alternative hypothesis: Series is stationary

    estimate largest root statistic p-value
pib                0.907     -1.129  0.5778
```

```
> boot_adf(dpib)
Progress: |----------|
          **********

        AWB bootstrap OLS test (with intercept) on a single time series

data: dpib
null hypothesis: Series has a unit root
alternative hypothesis: Series is stationary

     estimate largest root statistic p-value
dpib              -0.2977     -5.364       0
```

```
> boot_adf(dxa)
Progress: |----------|
          **********

        AWB bootstrap OLS test (with intercept) on a single time series

data: dxa
null hypothesis: Series has a unit root
alternative hypothesis: Series is stationary

    estimate largest root statistic  p-value
dxa              -0.1785     -4.796 0.001001
```

```
> boot_adf(xa)
Progress: |----------|
          **********

        AWB bootstrap OLS test (with intercept) on a single time series

data: xa
null hypothesis: Series has a unit root
alternative hypothesis: Series is stationary

   estimate largest root statistic p-value
xa               0.8759     -1.131  0.5543
```

```
> boot_adf(alm)
Progress: |----------|
          **********

        AWB bootstrap OLS test (with intercept) on a single time series

data: alm
null hypothesis: Series has a unit root
alternative hypothesis: Series is stationary

    estimate largest root statistic  p-value
alm              0.9501     -2.732 0.005003
```

	ALM	PIB	XA
Mean	304308.9	15540000	29502.45
Median	306031.0	16680000	26107.65
Maximum	460800.0	22080000	58665.00
Minimum	138391.0	7560000.	5027.700
Std. Dev.	118708.5	4725347.	18482.55
Skewness	-0.067726	-0.303939	0.167122
Kurtosis	1.452149	1.818275	1.828368
Jarque-Bera	1.810643	1.324492	1.113330
Probability	0.404412	0.515692	0.573117
Sum	5477561.	2.80E+08	531044.1
Sum Sq. Dev.	2.40E+11	3.80E+14	5.81E+09
Observations	18	18	18

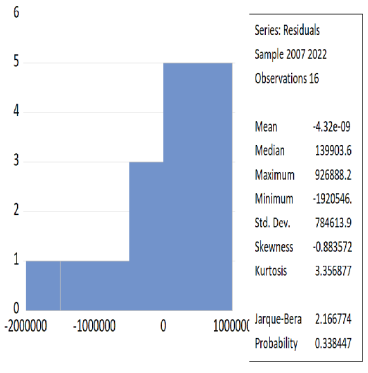
Unrestricted Test Equation:
Dependent Variable: PIB
Method: Least Squares
Date: 11/28/23 Time: 22:31
Sample (adjusted): 2007 2022
Included observations: 16 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PIB(-1)	0.005208	0.283594	0.018366	0.9858
XA	-2.121387	65.59044	-0.032343	0.9750
XA(-1)	378.5107	317.3140	1.192859	0.2671
ALM	18.95390	38.55808	0.491568	0.6362
ALM(-1)	124.3589	116.1868	1.070336	0.3157
ALM(-2)	-116.2441	81.76655	-1.421658	0.1929
C	6456134.	1642995.	3.929491	0.0044
FITTED^2	-4.16E-08	6.02E-08	-0.691803	0.5086

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	0.332399	Prob. F(6,9)	0.9034
Obs*R-squared	2.902413	Prob. Chi-Square(6)	0.8210
Scaled explained SS	1.082209	Prob. Chi-Square(6)	0.9823

Test Equation:



ECM

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	0.909283	Prob. F(2,7)	0.4456
Obs*R-squared	3.299464	Prob. Chi-Square(2)	0.1921

Test Equation:

Dependent Variable: D(PIB)
Method: ARDL
Date: 09/17/23 Time: 19:41
Sample: 2007 2022
Included observations: 16
Dependent lags: 2 (Automatic)
Automatic-lag linear regressors (2 max. lags): XA ALM
Deterministics: Unrestricted constant and no trend (Case 3)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 18
Selected model: ARDL(1,1,2)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COINTEQ*	-0.917543	0.209178	-4.386415	0.0011
D(XA)	8.005873	45.87754	0.174505	0.8646
D(ALM)	19.07145	30.36644	0.628044	0.5428
D(ALM(-1))	74.29364	26.17591	2.838245	0.0161
C	6336036.	1349912.	4.693668	0.0007

years	pib	alm	xa
2005	7560000	138391	5027,7
2006	8500000	146022	6168
2007	9350000	156083	6413,2
2008	11040000	164314	7457,9
2009	9970000	188482	8464,8
2010	11990000	214132	24006,9
2011	14590000	231846	26045,3
2012	16210000	266137	24477,9
2013	16650000	285480	32300,7
2014	17230000	326582	26170
2015	16710000	355983	23723,3
2016	17510000	381647	36118
2017	18880000	407474	38984,6
2018	20390000	423407	44116,6
2019	20500000	434701	49176,8
2020	18480000	445580	56464,4
2021	22080000	450500	57263
2022	22080000	460800	58665