Modeling of wheat's food gap in Algeria using the Autoregressive Distributed Lag (ARDL)-

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Abstract:
This study is intended to explain the relationship between wheat food gap and its determinants in Algeria from 1980 to 2018 ,by using the ARDL model, this study found that the Algerian's wheat agriculture is hostage to climatic conditions and far from registering and achieving acceptable levels of self-sufficiency, to overcome this shortfall, Algeria resorts to import from abroad, where common wheat comes first in agricultural imports as the basis for daily consumption of the Algerian individual. The country imports wheat from France, Canada, Germany, the United States of America, Spain and Mexico and recently from Russian after worsening ties between Algeria and Paris.

Keywords: the food gap, wheat, wheat production, ARDL
JEL Classification Codes: Q1; Q17; Q18

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1. INTRODUCTION

The subject of food security is extremely important due to their impact on the political, social and economic stability of the country. The need to achieve it is a strategic objective that Algeria seeks to get it. Achieving food security calls for the need to focus more on the agricultural sector in national public policies, that is why the Algerian state has endeavored to develop and improve this sector through the various policies and reforms it has undertaken since its independence.

Algeria is recording a significant increase in domestic demand for food compared to a decrease in its production. The growing needs of the population are increasingly met by imports, particularly cereals; cereal corps has represented the principal component of the human diet for thousands of years. It provides essential nutrients and energy in the everyday human diet through direct human consumption and also via meat production since they comprise a major livestock feed. The most common cereal include: wheat, rye, rice, corn, oat, and barley.

Therefore, Algeria must strive to reduce dependency to the other countries, and this will only be through an interest in the agricultural sector. From here, it stands out a problem of our research, which is:

What is the reality of wheat's food gap in Algeria?

1.1. Sub-questions

- Does the domestic production of wheat cover the demand for it?
- What are the Factors influencing the Algeria's food gap of wheat?

1.2. Study hypotheses

- The wheat production in Algeria is not enough to cover its growing domestic consumption needs, as Algeria import its wheat needs.
- The change climate and the increasing of population are considered one of the most important factors affecting the Algeria's food gap of wheat .

1.3. Study plan

To answer at the problem, we will address the following elements:

- description of variables
- Methods and Materials

2. description of variables :

This study is fanatical to estimate the relationship between wheat food gap and its determinants in Algeria

2.1. Alegria population growth

The evolution of the population weight and the characteristics of demographic growth obviously constitute major factors in the problem of food and nutritional security at present and in future too. Algeria is one of the most densely populated countries in the world, with an estimated population of 43.05 million on January 2019, up from the official 2013 census population of 37.9 million, (World Population Review, 2019) while it had less than 15 million inhabitants in 1960.

Table 1. Algeria Population by Year (Historical)

	Population	Yearly change%	Yearly change	Year	Population	Yearly change%	Yearly change
1960	11,057,863	2.50 %	256,716	2016	40,551,392	2.07 %	823,367
1965	12,550,885	2.57 %	298,604	2017	41,389,189	2.07 %	837,797
1970	14,464,985	2.88 %	382,820	2018	42,228,408	2.03 %	839,219
1975	16,607,707	2.80 %	428,544	2019	43,053,054	1.95 %	824,646
1980	19,221,665	2.97 %	522,792	2020	43,851,044	1.99 %	824,604
1985	22,431,502	3.14 %	641,967	2025	47,387,618	1.56 %	707,315
1990	25,758,869	2.80 %	665,473	2030	50,360,749	1.22 %	594,626
1995	28,757,785	2.23 %	599,783	2035	53,015,567	1.03 %	530,964
2000	31,042,235	1.54 %	456,890	2040	55,639,766	0.97 %	524,840
2005	33,149,724	1.32 %	421,498	2045	58,325,558	0.95 %	537,158
2010	35,977,455	1.65 %	565,546	2050	60,923,386	0.88 %	519,566
2015	39,728,025	2.00 %	750,114	2060	64,979,367	%0.56	/

source: world meters ,**Algeria Population (LIVE)**, https://www.worldometers.info/world-population/algeria-population/.

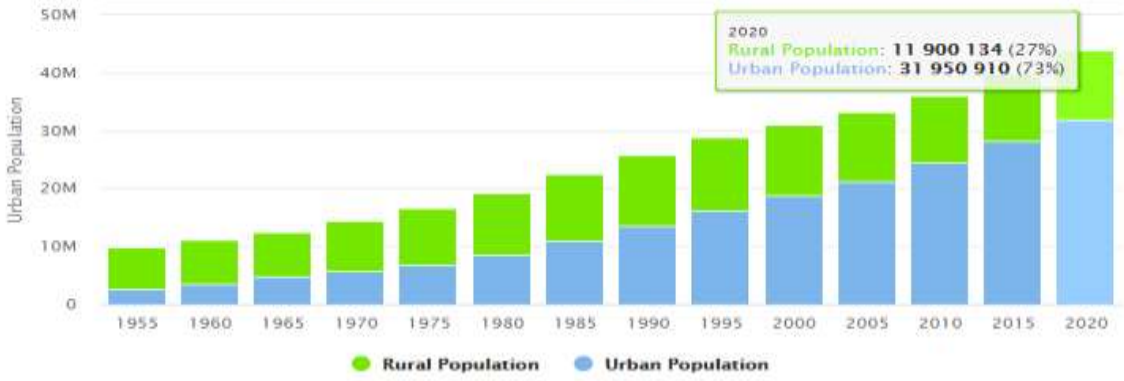
Following a very high in 1985 (above 3.14%), the population growth rate decreased quite rapidly until reaching the 1.32% level in 2005, the country having entered into demographic transition. However, this rate has picked up since then until it again exceeded 2% in 2015 (2.07% in 2017). According to specialists, this new "baby boom" (the third in 50 years after that of 1968 and 1982), is partly due to a marriage rate that has doubled. Indeed, more than 369,000 marriages were registered during the year 2015 against 177,000 in 2000, an average of 9 marriages per 1,000 inhabitants against 5/1000, which explains this growth in the birth rate. Rather, it appears that the sharp decline in the rate of population growth observed from 1989 onwards can be explained more by the start of the long economic

crisis and the fears it has posed for the future in terms of employment and living conditions. The postponement of the creation of new households has temporarily blocked population growth Since 2000, the security and stability restored, ambitious social housing construction programs, Stimulating job creation and progressive improvement of the purchasing power, these are all come from the demographic recovery noted However, we cannot avoid the fact that the evolution of the population's weight clearly represents a major determinant in the problem of food and nutritional security. (CREAD, 2018, p. 22)

The evolution of the Algerian population constitutes in the future a real challenge to food and nutritional security for this 21st century. A United Nations study provides, on the basis of the average hypothesis, that this population is expected to grow by 52% to 63 million by 2050 before doubling to 90 million by 2100.

Roughly three-quarters (31,236,431 people in 2019) of Algeria's population live in urban areas, and thus, there are several sizable cities. The largest of these cities is the appropriately named capital Algiers, with a population of 3.416 million. The only other city with a population exceeding one million is Oran. A few other notable cities are Constantine, Annaba, Blida, and Banta, all of which have a population under 500,000. (World Population Review, 2019)

Fig .1. Algeria Urban vs. Rural Population from 1955 to 2020



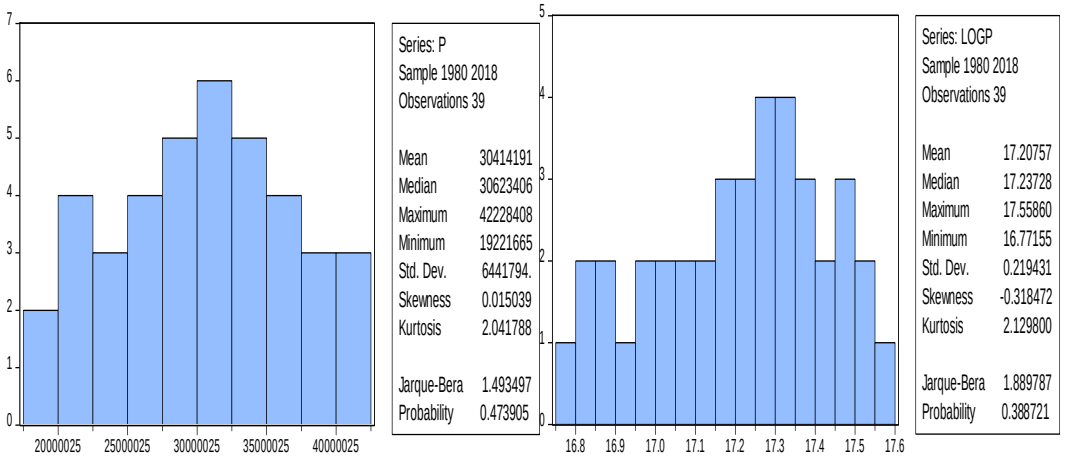
Source: world meters ,**Algeria Population (LIVE)**, https://www.worldometers.info/world-population/algeria-population/ .

Through the figure, we note that the number of rural residents is constantly declining, due to the migration of many villagers, especially the youth component, to search for a job in the city, where there are aspects of a decent life. Statistics show that the average population in these rural areas becomes negative in the near future leading to the low rate of agricultural

development. Compounding the problem is the small area of agricultural land for many farmers, which forces them to close their farms.

By Speaking about the Algeria's population time series during the period 1980-2018,it follows the normal distribution, and the following figure shows that:

Fig .2. Descriptive statistics of the population (1980-2018)



source : Eviews 10 output

From the figure we note that the highest value of population was at 2018 by 42228408 people, and the lowest value was recorded in 1980 with 19221665 people. While the series mean was estimated by 30623406 people, and a standard deviation was recorded by 0.219 (According to logarithmic population series LOGP), this value reflects that the series homogeneity. We find also that the series follows a normal distribution, according to Jarque-Bera- test of normality- (Jarque Bera = 1.89 Prob = 0.388721> 0.05).

2.2. Algeria wheat consumption

Algeria is a major consumer of cereals and considers wheat as the major staple food. Wheat is used mainly for bread and couscous. Algerian wheat consumption has risen in the last years as a result of increased population growth. The following table shows that:

Table 2. wheat consumption in Algeria during the period 1980-2018

Unit: Tonnes

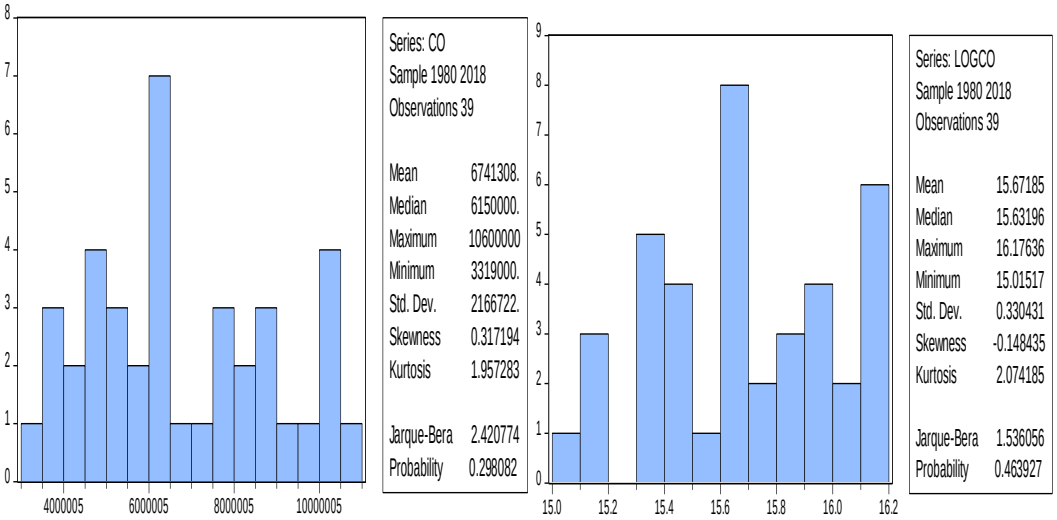
Years	**Consumption**	Years	**Consumption**
1980	3667000	2000	6150000

1981	3319000	2001	6372000
1982	3644000	2002	6650000
1983	3634000	2003	7050000
1984	4446000	2004	7550000
1985	4460000	2005	7750000
1986	4740000	2006	7850000
1987	4987000	2007	8050000
1988	4773000	2008	8300000
1989	4870000	2009	8550000
1990	5160000	2010	8750000
1991	5000000	2011	8950000
1992	5300000	2012	9450000
1993	5700000	2013	9850000
1994	6007000	2014	10005000
1995	5966000	2015	10250000
1996	6011000	2016	10350000
1997	6050000	2017	10450000
1998	6150000	2018	10600000
1999	6100000		

source: U.S. DEPARTMENT OF AGRICULTURE (USDA).

The time series of Algeria wheat consumption during the period 1980-2018 follows the normal distribution, according to test of Jarque Bera ((Jarque Bera = 2.42,Prob = 0.2980> 0.05),the following figure shows that:

Fig .3. Descriptive statistics of Algeria wheat consumption (1980-2018)



source : Eviews 10 output

From the figure we note that the maximum value of wheat consumption was at 2018 by 10600000 tonnes, and the minimum value was recorded in 1981 with 3319000 tonnes. While the series mean was estimated by 6741308 tonnes.

2.3. wheat production

Generally, cereals production occupies an important place in agriculture as it represents the main source of food and includes a large group of crop structures, perhaps the most prominent of which is wheat. The following figure shows the development of wheat production in Algeria during the period (1980- 2018):

Table 3. wheat production in Algeria during the period 1980-2018

Unit: Tonnes

Years	Production	Years	Production
1980	1511426	2000	760361
1981	1218380	2001	2039213
1982	977070	2002	1501803
1983	789786	2003	2964852
1984	886469	2004	2730700
1985	1478018	2005	2414728
1986	1228800	2006	2687930
1987	1174800	2007	2318963
1988	614420	2008	1111033
1989	1152100	2009	2953117
1990	750080	2010	2605178
1991	1869400	2011	2910890
1992	1836750	2012	3432231
1993	1016500	2013	3299049
1994	713964	2014	2436197
1995	1499920	2015	2656731
1996	2982604	2016	2440097
1997	661514	2017	2436503
1998	2280000	2018	3981219
1999	1470000		

source: statistics of Food and Agriculture Organization (FAO)

During the period 1980-2018, the wheat production has witnessed a fluctuation between the increase and decrease .By speaking about the period of government spending programs (2001/2019), these programs were accompanied by many reforming policies in the agricultural sector, to name some: the National Plan for Agricultural and Rural Development 2000/2004, the Agricultural and Rural Renewal Policy 2008/2014,...and other policies that were encouraged by those programs. In this period (2001/2018) wheat production has achieved a significant improvement compared to the previous period(1980-2000) except two year (1996-1998), where production reached about 29.8 and 22.8 million kantars Respectively, which is the best result recorded by Algeria during the period 1980-2000. Furthermore, wheat production has witnessed a significant decline starting from the year 2014, then return to record a great increase in 2018 by about 39.81 million kantars.

Despite this improvement in Algeria wheat production, it remains weak, as it covers only a small percentage of local needs .Therefore the quest for increased production of the strategic crop has become an urgent necessity, in order to alleviate the deficit that the country is witnessing and meet the national needs in this field.

erratic climatic conditions is one of the main natural factors in declining wheat production growth and the production of agricultural crops in Algeria, additionally the transformations that the world of agriculture knows as a whole.

The harvested production of **durum wheat** in Algeria was 20.2 million kantars in 2015 (the Ministry of Agriculture, Rural Development , 2018) about 53.71 % of global cereal production. This represented a rebound of +9.5 % or 1.76 million kantars more than in 2014, in the same context, Algeria's harvested production of durum wheat in 2015 remained some 3.87 million kantars lower than the record harvest of 24.07 million kantar recorded in 2012. (the Ministry of Agriculture, Rural Development , 2018)

By speaking about 2005-2015 period, durum wheat production has recorded a fluctuation of increase and decrease, in 2008 Algeria's production of durum wheat witnessed a great decline 8.14 million kantars.

Tiaret accounted for around one-tenth (8.77 %) of the Algeria durum wheat production in 2015, Guelma was the next largest durum wheat producers, accounting for (6.81 %) of the Algeria’s production ,A. TEMOUCHENT (5.36 %). Ain Defla, Bouira 4.95 % of Algeria’s production, these **states** together contributed to 31% of the Algeria total production. Among these States, Tiaret was the largest producer of common

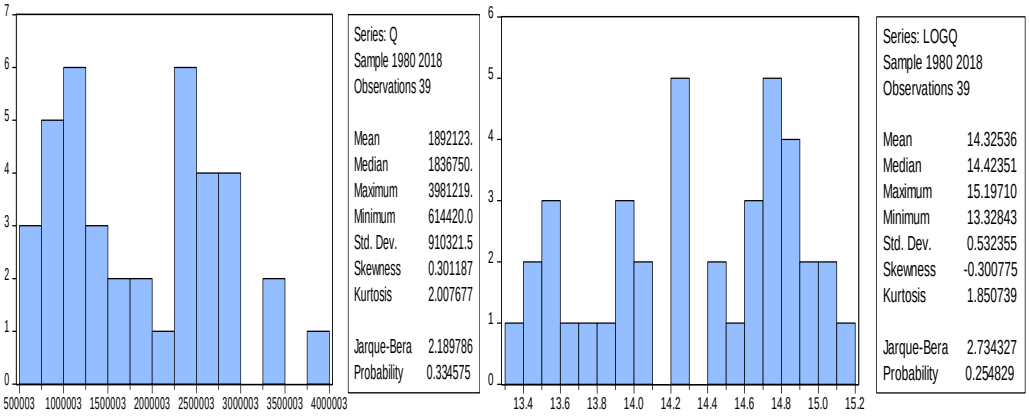
and durum wheat in 2015. (the Ministry of Agriculture, Rural Development , 2018)

As regarding common wheat, during the period 2005/2015 it has witnessed a fluctuation of increase and decrease. Algeria harvested 6.37 million kantars of common wheat in 2015, representing 16.94% of all cereal grains harvested. This was 0.45 million tonnes more than in 2014, an increase of +7.6 %.

Tiaret harvested 630000 kantars of common wheat in 2015, a little lower than one-tenth (9.89 %) of Algeria's total production. mascara harvested 558700 kantars (8.77 % of Algeria's total production) and TLEMCEN harvested 444500 kantars (6.98 %). (the Ministry of Agriculture, Rural Development , 2018)

The time series of Algeria wheat production during the period 1980-2018 follows the normal distribution, according to test of Jarque Bera ((Jarque Bera = 2.19,Prob = 0.33457> 0.05),the following figure shows that:

Fig .4. Descriptive statistics of Algeria wheat production (1980-2018)



source : Eviews 10 output

From the figure we note that the maximum value of wheat production was at 2018 by 3981219 tonnes, and the minimum value was recorded in 1981 with 614420 tonnes, while the series mean was estimated by 1892123 tonnes.

By speaking about standard deviation, it was recorded 0.53 (According to logarithmic production series LOGQ) this value reflects that the series homogeneity.

2.4. wheat productivity(yield)

In the table below, we see the yield per hectare of wheat over the 39 year in the Algeria from 1980 still to 2018. Overall, we see that the yield per

hectare of wheat from 1980 to 1990 were relatively weak, which the productivity was improved by the 1990s, while yield per hectare of wheat between 2000 and 2018 was growing 2 fold compared to period of 1980s. But from 2014 wheat productivity in the Algeria has been relatively stagnant, in 2018 yield in wheat again has rising from 11501 hg/ha in 2017 to more than 19000 hg per hectare in 2018.

Table 4. Yield per hectare of wheat in Algeria during the period 1980-2018

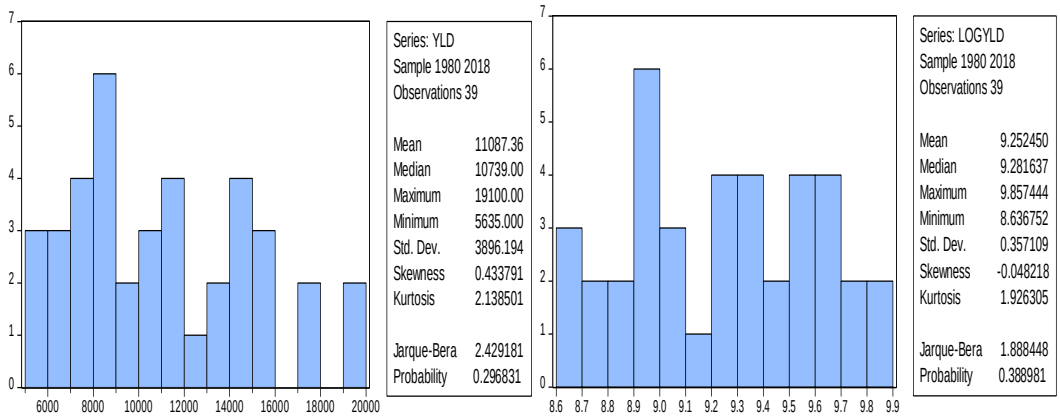
Unit: hg/ha

Years	Production	Years	Production
1980	7297	2000	9194
1981	6720	2001	11104
1982	5965	2002	10739
1983	5635	2003	14480
1984	5730	2004	13582
1985	8861	2005	15057
1986	8084	2006	15068
1987	7777	2007	12742
1988	6006	2008	11038
1989	7821	2009	15975
1990	6315	2010	14838
1991	10809	2011	17405
1992	9939	2012	17639
1993	8097	2013	19100
1994	7999	2014	14753
1995	8924	2015	14640
1996	13090	2016	11833
1997	8016	2017	11501
1998	8847	2018	19076
1999	10711		

source: statistics of Food and Agriculture Organization (FAO)

The time series of yield per hectare of wheat in Algeria during the period 1980-2018 follows the normal distribution, according to test of Jarque Bera,((Jarque Bera = 2.43,Prob = 0.296831> 0.05),the following figure shows that:

Fig.5. Descriptive statistics of wheat Yield per hectare in Algeria during the period 1980-2018



source : Eviews 10 output

From the figure we note that the maximum value of wheat production was at 2013 by 19100hg/ha, and the minimum value was recorded in 1983 with 5635 hg/ha, while the series mean was estimated by 11087.63 hg/ha.

2.5. The Food gap of wheat

The Algeria relies heavily on imports of wheat, even in years with ample domestic production. In the last five years, the country imported an average of about 8 million tonnes of mostly common wheat per year, representing about 70 percent of its domestic utilization. (fao, 2019)

Table 5. The Algerian Food gap of wheat-1980/2018-

UNIT: Tonnes

Years	Food gap of wheat	Years	Food gap of wheat
1980	2155574	2000	5389639
1981	2100620	2001	4332787
1982	2666930	2002	5148197
1983	2844214	2003	4085148
1984	3559531	2004	4819300
1985	2981982	2005	5335272
1986	3511200	2006	5162070
1987	3812200	2007	5731037
1988	4158580	2008	7188967
1989	3717900	2009	5596883
1990	4409920	2010	6144822
1991	3130600	2011	6039110
1992	3463250	2012	6017769
1993	4683500	2013	6550951

1994	5293036	2014	7568803
1995	4466080	2015	7593269
1996	3028396	2016	7909903
1997	5388486	2017	8013497
1998	3870000	2018	6618781
1999	4630000		

Source: preparing of researchers depending on:

- Statistics of Food and Agriculture Organization (FAO).
- U.S. DEPARTMENT OF AGRICULTURE (USDA).

Although domestic production has improved over the years, thanks to efforts to clear some of the obstacles that have traditionally hindered the sector's development, such as financing, legislation, insufficient infrastructure and land ownership .While the record wheat harvest was a highlight of 2018, Algeria is still quite a way off from significantly reducing its import bill for wheat products, as wheat production does not meet domestic demand. Therefore, Algeria continues to import wheat, essentially common wheat. Less common wheat is planted than durum and barley. Bread wheat represented 75 to 83 percent of the wheat imports. (Hales Nabila, 24/03/2019, p. 7) While Algeria's imports of durum wheat are lower compared to common wheat due to the abundant production that covers a high proportion of domestic demand, consequently Algeria achieve a high rates of self-sufficiency in relation to durum wheat.

It is hard for Algeria to count on domestic durum wheat supply due to the wide production swings, because of climatic fluctuations. Where durum wheat is considered a staple part of the diet of Algerian citizen.

Algeria wants to increase the self-sufficiency of durum wheat, for this reason the Algerian government plans on increasing the irrigated land to nearly 5 million acres by the end of 2019 (or by more than 50%).

Since Algeria has suffered from water scarcity and droughts, water resource management and technology is crucial for these lofty goals, but in order to meet its agriculture goals, it will need to increase its waters resouces. But all this takes time; it's unlikely that wheat durum production will skyrocket overnight. This means that Algeria will have to keep importing wheat durum.

Algeria imported 7.2 million tonnes of wheat in 2018, where Algeria's wheat output for same year reached 3.9 million tonnes, 62.5% higher than in the previous season. That was considered the largest harvest for wheat in

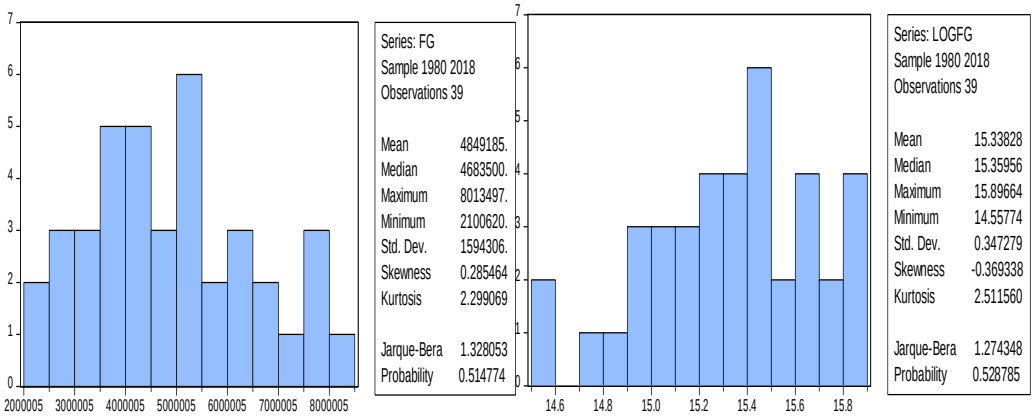
five decades. Whereas Algeria imported 8.1 million tonnes of wheat in 2017 and 8.23 million tonnes the previous year 2016.

By speaking about the period 2005/2015, wheat imports has witnessed a fluctuation of increase and decrease, with significant high import rates in 2015 about 8.5 million tonnes. In the same context, Algeria has recorded self-sufficiency rates in wheat ranged between 14% and 35% during the period 2005/2018.

Algeria, the world's third largest wheat importer, previously brought in up to 40% of France's wheat output annually but its move towards Russian wheat was an indication of worsening ties between Algiers and Paris. (ghanmi, 2018) Also Algeria imports from Argentina, Latvia, Sweden, Germany, United Kingdom, Mexico, Canada and United States.

The time series of wheat food gap during the period 1980-2018 follows the normal distribution, according to test of Jarque Bera ((Jarque Bera = 1.32, Prob = 0.5147> 0.05),the following figure shows that:

Fig. 6. Descriptive statistics of The wheat Food gap in Algeria -1980/2018-



source : Eviews 10 output

By speaking about the maximum value of the wheat food gap in Algeria was at 2017 by 8013497 tonnes, and the minimum value was recorded in 1981 with 2100620 tonnes, while the series mean was estimated by 4683500 tonnes, the value of the standard deviation was 0.35 (According to logarithmic food gap series LOGFG) this value reflects that the series homogeneity.

3. Methods and Materials

This study investigates the relationship between wheat food gap and its determinants in Algeria, by using the ARDL model. A time series data spanning from 1980 to 2018 were employed from Food Agriculture

Organization (FAO) and U.S. DEPARTMENT OF AGRICULTURE (USDA).

We will use logarithms of the variables in order to translate variable coefficients as elasticities. The series of steps in the ARDL procedure is the investigation of: (1) stationarity, (2) cointegration, and last but not least (3) causality. There are other ways to proceed to causality analysis without the first two steps, but this occurs within other methodological frameworks. **(Menegaki, 2019, p. 2)**

The variables used in this study are:

LFG: food gap (tonnes) as a dependent variable

LP: population (people) as an independent variable

LQ: wheat production (tonnes) as an independent variable

LCO: Consumption (tonnes)as an independent variable.

LYLD: yield (hg/ha) as an independent variable.

A linear function can be used to express the relationship between wheat food gap and its determinants in Algeria, showed in Eq:

$LFG_t=\beta_0+\beta_1 LCO_t+\beta_2 LQ_t+\beta_3 LP_t+\beta_4 LYLD_t+\varepsilon_t$

ε_t :is the error term .

β_0, β_1, β_2, $\beta 3$, β_4: are the elasticities to be estimated.

3.1. Unit root test

After a presentation of the descriptive statistics of the time series, the first step in the ARDL analysis, is the unit root analysis. It informs about the degree of integration of each variable. To satisfy the bounds test assumption of the ARDL models, each variable must be I(0) or I(1). Under no circumstances, should it be I(2). Unit root analysis is performed with a long array of tests such as for example the augmented Dickey Fuller (ADF) and the Kwiatkowski–Phillips–Schmidt–Shin (KPSS), the Phillips–Perron (PP), the Ng–Perron test, the cross-sectional augmented IPS-CIPS (Pesaran 2007), the LS (Lee and Strazicich 2003), and many others. Each one is more compatible with different data characteristics. Our study will focus at standard augmented unit root test of Dickey and Fuller. As showing in the Table 6:

Table 6. Unit root test (ADF)

Variables		Level		1 st différence	
LFG	Intercept	-2.188080 (0.2138)	No Stationary (unit root)	/	/
	Trend and	-5.688469	Stationary	/	/

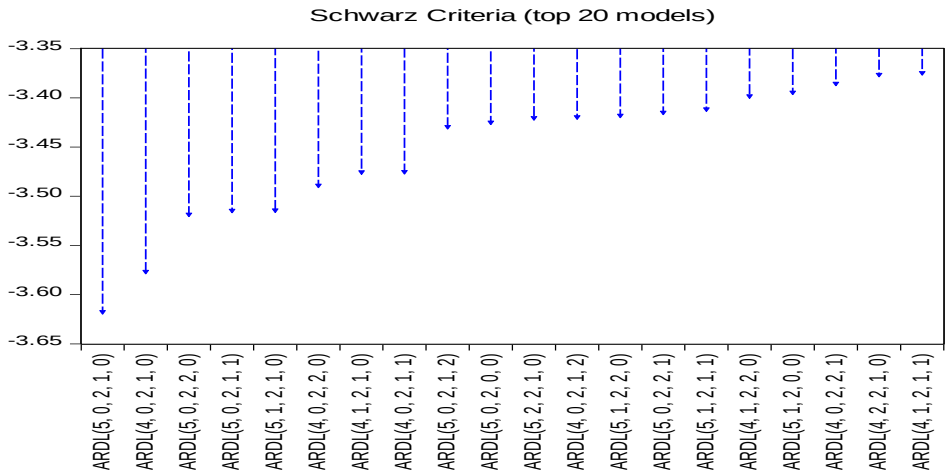
	intercept	(0.0002)			
	None	1.5824 (0.9699)	No Stationary	/	/
LYLD	Intercept	-1.792953 (0.3782)	No Stationary	/	/
	Trend and intercept	-4.964028 (0.0014)	Stationary	/	/
	None	0.869685 (0.8931)	No Stationary	/	/
LQ	Intercept	-3.508550 (0.0131)	Stationary	/	/
	Trend and intercept	-6.842759 (0.0000)	Stationary	/	/
	None	0.169451 (0.7298)	No Stationary	/	/
LP	Intercept	-1.274487 (0.6307)	No Stationary	/	/
	Trend and intercept	-6.842759 (0.0000)	Stationary	/	/
	None	0.704031 (0.8630)	No Stationary	/	/
LCO	Intercept	-0.740394 (0.8242)	No Stationary	-8.652584 (0.0000)	Stationary
	Trend and intercept	-2.996786 (0.1463)	No Stationary	-8.836097 (0.0000)	Stationary
	None	3.775401 (0.9999)	No Stationary	-2.218971 (0.0274)	Stationary

source: Eviews 10 output

The results in Table 6 show that all the variables in ADF test are stationarity at level except one variable, which became stationary at first difference, wheat food gap, population, wheat production and yield are integrated of order zero I(0) but wheat Consumption integrated of order one I(1); hence, the ARDL model can be applied in this case, to determine the long-run cointegration between the variables of study.

The second step was the estimation of a basic ARDL model that explains FG and its determinants. To determine the lag structure for the regressors in the model, the ARDL(5.0.2.1.0) model is chosen that minimizes the Schwarz criterion (SC).

Fig .7. Optimum lag selection



source : Eviews 10 output

3.2. Bound test:

The ARDL bound test is based on the Wald test (F-statistic). When the computed F-statistic is greater than the upper bound critical value, we can reject the null hypothesis, this means that the variables are co-integrated. (Gaham & Cherakrak, 2020, p. 455)

Table7. Bounds Test

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	22.29902	10%	2.2	3.09
K	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

source : Eviews 10 output

The results of the bounds cointegration test demonstrate that the null hypothesis of against its alternative is easily rejected at the 5% significance level, the calculated F statistics 22.299 surpassed the upper Bound critical values, thus indication the existence of a steady state long-run relationship among FG and its determinants.

3.3. Co-integration of long run relationship:

After making sure there is a long term relationship between the wheat food gap and its determinants in Algeria, Next step we compte the estimates of the ARDL long-run coefficient for the model and that of the error correction model (ECM) as well.

Table 8. Estimated long run coefficients using the ARDL approach

Levels Equation

Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
LCO	0.843383	0.164612	5.123460	0.0000
LP	0.722276	0.218566	3.304608	0.0034
LQ	-0.249214	0.030824	-8.085119	0.0000
LYLD	-0.077300	0.032454	-2.381850	0.0268
C	-6.135396	1.561894	-3.928177	0.0008
EC = LFG - (0.8434*LCO + 0.7223*LP -0.2492*LQ -0.0773				
*LYLD -6.1354)				

source : Eviews 10 output

The estimated variables coefficients of the long-run relationship are statistically significant at less than 5 %(wheat Consumption, population, wheat production and yield).long-term influence of the wheat consumption on food gap seems to be statistically significant at the 1% significance level, its increase by 1% would invoke food gap increase by 0.84 % , Alternatively, the wheat production increasing by 1 %leads to decrease on FG by 0.24 % ,while The yield (per hectare) variable is negatively signed and significant at the 5% level , This means, the higher on yield per hectare of wheat(by 1%) leads to low in the food gap by 0.077 %. While ,population coefficient have a positive sign and statistically significant at less than 5%,This means that the increasing on population by 1 % , its leads to increase on FG by 0.72 % ,This is indicative of the growing food gap problem with high population in Algeria.

Table 9. ECM Regression				
Case 2: Restricted Constant and No Trend				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LFG(-1))	0.221284	0.045183	4.897496	0.0001
D(LFG(-2))	0.176310	0.045222	3.898794	0.0008
D(LFG(-3))	0.042570	0.038234	1.113403	0.2781
D(LFG(-4))	-0.065559	0.025851	-2.536044	0.0192
D(LP)	52.89612	5.756774	9.188501	0.0000
D(LP(-1))	-43.37092	5.446108	-7.963653	0.0000
D(LQ)	-0.281555	0.008784	-32.05316	0.0000
CointEq(-1)*	-1.586270	0.123248	-12.87050	0.0000
R-squared	0.989967	Mean dependent var		0.018244
Adjusted R-squared	0.987265	S.D. dependent var		0.204726

S.E. of regression	0.023103	Akaike info criterion	-4.495401
Sum squared resid	0.013877	Schwarz criterion	-4.136258
Log likelihood	84.42182	Hannan-Quinn criter.	-4.372923
Durbin-Watson stat	2.328298		

source : Eviews 10 output

The findings displayed a valid short run relationship between wheat food gap (FG) and its determinats in Algeria. The coefficient of error term is displaying the value of around - 1.58 propose that around 158% of instability is adjusted in the present year. Results also error correction coefficient (ECTt-1), is negative and significant at less than 1%, the coefficient indicates the adjustment speed to restore equilibrium in the dynamic model that is the effect of a shock will be corrected by 158%.

3.4. Diagnostic Tests after Cointegration

A model to be trusted, it must be robust. To support robustness of an estimated model, one needs to peruse various diagnostic tests. Typical diagnostic tests follow to investigate the goodness of fit, stability, parsimoniality, functional form, and a well-behaved model in general. The Breusch Godfrey serial correlation LM test, the Breusch–Pagan Godfrey Heteroskedasticity test or the White test, and the Jarque–Bera test are some of the tests encountered in these applications. In addition to that, the Ramsey reset test is used for the functional form. Besides the latter, the variance inflation factor (VIF) for multicollinearity might be useful in cases where there is evidence of multicollinearity**.** (Menegaki, 2019, p. 4)**.**

- **serial correlation (Breusch-Godfrey test)**

From Table (10) below, the test of serial correlation was carried out on the model; the result revealed that there is no serial correlation, since the (f-statistic= 0.95 at significance level (Prob=0.40 >0.05)

Table 10. Serial Correlation

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.955745	Prob. F(2,19)	0.4023
Obs*R-squared	3.107892	Prob. Chi-Square(2)	0.2114

source : Eviews 10 output

- **Heteroskedasticity test**

The test of Heteroskedasticity test was carried out on the model, the result revealed that the variance of the residual is constant, since the (f-statistic=0.59 ,Prob = 0.8143> 0.05).

Table 11.Heteroskedasticity test

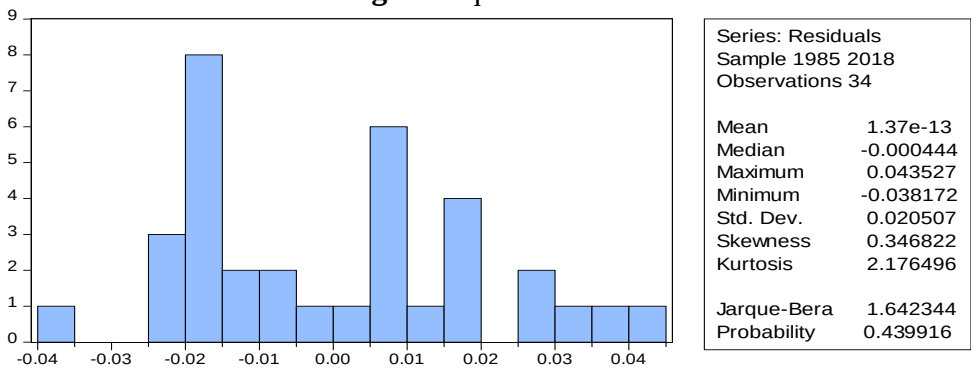
Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	0.593175	Prob. F(11,22)	0.8143
Obs*R-squared	7.777319	Prob. Chi-Square(11)	0.7331
Scaled explained SS	1.745303	Prob. Chi-Square(11)	0.9992

source : Eviews 10 output

- **test of normality**

Jarque-Bera test is a test of normality, since the (jarque bera = 1.64 ,Prob = 0.4399> 0.05). We conclude that the residual is normally distributed.

Fig .8. Jarque-Bera test

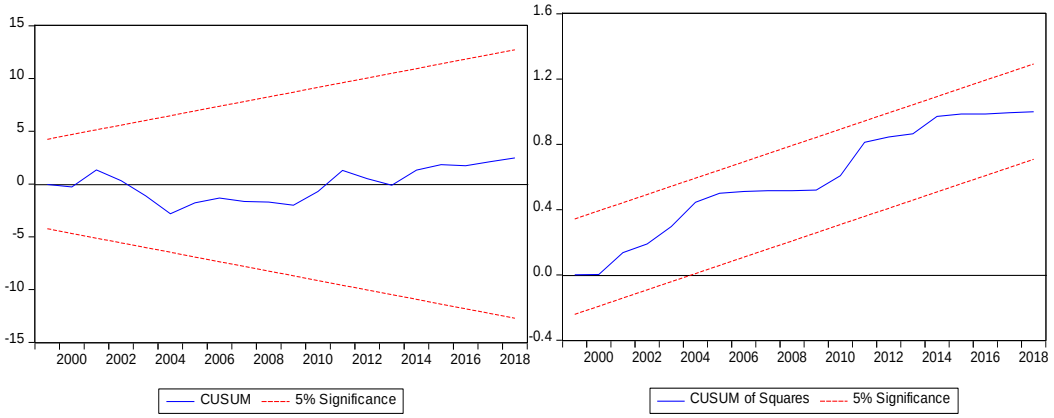


source : Eviews 10 output

3.5. Test of Stability for the Long-Run Model

The results of the cumulative sum (CUSUM) and the cumulative sum of squares (CUSUMSQ) of the standardized recursive residuals are used to check the stability of the ARDL error-correction model as proposed by -Brown & Evans, 1975- **(Mezouri, 2020, p. 82)** , The results indicate the absence of any instability of the coefficients because the plot of the CUSUM and CUSUMSQ statistic fall inside the critical bands of the 5% confidence interval of parameter stability. hence these statistics confirm the stability of the long run coefficients of regressors.

Fig .9. Plot of cumulative sum (CUSUM) and CUSUM of squares tests



source : Eviews 10 output

4. CONCLUSION

Wheat is Algeria's major grain crop, It represents a significant percentage of the total cultivated areas. In spite of the government's longstanding objective of boosting productivity, however, wheat self-sufficiency dropped from 91 percent at independence to 37 percent in 2018. The drop resulted from such factors as the rapidly multiplying population, erratic climatic conditions, agricultural mismanagement, and rural migration to urban centers.

Although wheat production has improved in recent years, it is not enough to cover its growing domestic consumption needs, as Algeria import its wheat needs from :Argentina ,Latvia ,Sweden ,Germany, United Kingdom, Mexico, Canada, United States and recently from Russian after worsening ties between Algiers and Paris. The most important results of the study:

- The estimated variables coefficients of the long-run relationship are statistically significant at less than 5 % significance level.

- The R-squared statistic shows that the independent variables explain more than 98% of the wheat food gap.

- The results show that there is cointegration among the variables specified in the model, as we found a significant positive relationship between the population and the wheat food gap, also there is a significant positive relationship between wheat consumption in Algeria and food gap. in other side, there is an a significant inverse relationship between the Algeria’s wheat production and the wheat food gap, and a significant

negative relationship between the wheat yield per hectare and food gap of wheat.

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