Attempting to forecast unemployment rates in Algeria during the period between 1984 and 2024 A comparative study of both the ARDL and BLS method

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Abstract:

This research paper aims to apply some econometric models and quantitative methods to analyze the relationship between unemployment and economic growth in Algeria in the period from 1984 to 2024; in an attempt to forecast unemployment rates. The Hodrick-Prescott filter technique was used to extract the data series of both the natural unemployment rate and the potential Gross Domestic Product. The study utilized the Autoregressive Distributed Lag (ARDL) and the LS with Breakpoints (BLS) method within the framework of the Okun model of unemployment.

The empirical analysis revealed a fluctuating relationship between unemployment and economic growth, as the inverse relationship was observed in 2019 and 2021, but not in 2020 and 2022, which aligns logically with the actual economic conditions during those years. The predictive generated by the ARDL model conformed to economic theory, while those obtained from BLS model contradicted economic theory but were consistent with the Algerian economic reality.

Keywords: unemployment rate, economic growth rate, forecasting, ARDL, LS with Breakpoints.

JEL Classification : J21 ; O47 ; C53 ; C5.

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1. Introduction:

Unemployment is one of the economic problems that lead to global economic imbalances. It is one of the topics that have aroused the interest of many economists and thinkers, and there are many economic theories which explain this phenomenon in an effort to increase employment in exchange for a low rate of unemployment. Unemployment is also one of the main problems that hinder progress and development in most countries of the world at different levels of progress and their types of economic, social and political systems. It is one of the most prominent challenges these countries are facing because they are seeking to develop strategies and plans to achieve the largest number of jobs, as well as the rate of economic growth. It is one of the most important indicators of the performance of economic activity of any country, as it reflects the total activity of the state and its economic performance during a year.

The topics of economic growth were associated with unemployment and attracted the attention of many experts, economists and economic policymakers. (Arthur OKUN, 1962) was concerned with the relationship between economic growth as measured by the rate of real GDP and unemployment in the United States of America; this relationship was called the Okun Act, and this relationship allows the determination of the break-even growth rate through which the unemployment rate begins to decline.

To apply the Okun relationship in predicting unemployment rates, the potential growth of the economy should first be estimated, then the Okun relationship can be used to estimate future unemployment rates based on projected actual growth. Okun's relationship is usually expressed by a simple equation that links the unemployment rate (u) to the gap between actual growth (y) and potential growth (y*), with the use of a coefficient (b) that measures the extent to which unemployment rates are affected by growth: $u = b(y - y^*)$.

Economic recovery is often presented as the most appropriate solution in the case of unemployment, but the rate of growth does not necessarily mean a decrease in the unemployment rate as the labor force can grow at a higher rate than the employment rate, as economic growth creates jobs if its growth rate is greater than the rate of productivity. The elasticity of employment related to economic growth can also depend on technical progress and the production cycle (Huang, H., Lin, S., 2008, p. 372).

Similar to other countries, unemployment is a major economic and social challenge in Algeria, affecting economic stability and social well-being. With increasing global and domestic economic challenges, it has become imperative to develop accurate quantitative tools for forecasting unemployment rates to assist decision-makers in implementing effective policies.

In order to analyze the relationship between the two variables (economic growth and unemployment), a number of attempts were made to measure this relationship using econometric modeling and statistical methods. We list some of these studies:

- Ayira KOREM's study entitled "Croissance économique et chomage: evidence empirique de la loi d'OKUN dans les pays de l'UEMOA" aimed to test the validity of the relationship developed by OKun in the countries of the West African Economic and Monetary Union (UEMOA) during the period from 1986 to 2018. To achieve this, a self-regressive non-linear model with graduated delays was used. The results indicate that OKun's law, which predicts a negative relationship between unemployment and growth, has been verified in both Niger and Togo, while it has not been verified in the other six countries (Benin, Burkina Faso, Côte d'Ivoire, Guinea-Bissau, Mali, and Senegal). However, these results confirm the hypothesis that cyclical unemployment is more sensitive to negative differences in GDP compared to positive in the Union countries. Tests of causality show that it is the productivity gap that most significantly affects overall unemployment. Based on these findings, it is clear that one of the challenges facing economic policies in the countries of the Union is to focus on improving the quality of the workforce as well as creating jobs (KOREM, 2021).
- The study of Abbas Fouad Abbas Hassan, entitled "The Impact of Economic Growth on Unemployment - A Case Study of the Kingdom of Saudi Arabia during the Period 1980-2018", aimed to analyze the relationship between unemployment and economic growth in the Kingdom of Saudi Arabia. Using the causality test, the co-integration test and the Okan relationship, the results showed a strong correlation between economic growth and the unemployment rate, and recommended the development of new economic policies to reduce dependence on oil and increase investments (عباس فؤاد عباس حسن، 2020).
- The aim of this research is to study the relationship between unemployment and economic growth in Algeria from 1980to 2017. To test this relationship an error correction model (VECM) was used. the empirical results indicated that economic growth does not significantly affect the unemployment rate. In addition, the causality test confirms that there is no correlation between the unemployment rate and economic growth (Bouchenaki & Fekir, 2021) .

Our study agreed with the previous studies mentioned in the research on the relationship between economic growth and unemployment, while it disagreed with them in terms of the statistical methods and methods used for the study in addition to the difference in our study in time and spatial limits.

This study seeks to apply some quantitative methods to the relationship between economic growth and unemployment in Algeria, and to predict it in the future as a way to help officials make appropriate decisions.

Statistical data for these two variables were taken from the National Bureau of Statistics database from 1984 to 2024.

In light of the above, the general problematic of this paper can be formulated as follows:

How effective are quantitative methods in estimating the relationship between unemployment rates and economic growth in Algeria, and can they be relied upon to predict future unemployment rates?

To answer this problem, we ask the following sub-questions:

1. Which quantitative methods are most appropriate for predicting unemployment rates?

2. How can the quality and accuracy of quantitative models used to predict unemployment rates be measured?

To address this topic, we decided to put forward the following research hypotheses:

- Quantitative methods (e.g. ARDL and Breakls) can be used to accurately predict unemployment rates in Algeria.

- There is a statistically significant relationship between unemployment rates and economic growth.

- Historical data on unemployment in Algeria provide a sufficient basis for building reliable predictive models.

The importance of the study: The importance of the study lies in deriving an econometric model, which is used to determine the relationship between unemployment and economic growth and to predict unemployment rates in Algeria by using the Autoregressive Distributed Lag (ARDL) model and the method of least squares at intervals (Break ls). The latter seeks to improve and understand the factors affecting unemployment in Algeria and provide clear insights on the relationship between economic growth and the unemployment rate in addition to contributing to enriching the library of academic literature on labor economics and unemployment in Algeria.

Objectives of the study: This study aims to:

- Studying the impact of economic growth on unemployment rates in Algeria,

- Clarifying the relationship between unemployment and economic growth econometrically to support decision-makers in making appropriate economic decisions,

- Analyzing the reality of unemployment in the Algerian economy,

- Finding an economic model to measure the relationship between economic growth and the unemployment rate and applying it,

-Identifying ARDL models and the least squares method at intervals (Breakls).

In this study, the analytical descriptive approach was used to understand and analyze the relationship between the different variables of the model. The statistical approach was also used to provide an objective way to measure and interpret the data. This analysis relied on annual data on unemployment rates and real GDP from 1984 to 2024, utilizing statistical tools and tests along with the Eviews13 software package.

To cover various aspects of the subject under study, this study is divided into three main sections:

- The theoretical foundation of unemployment and economic growth;
- The methodology used ;
- Discussion of the results.

2. The theoretical foundation of unemployment and economic growth: In this section, we will address the concept of both unemployment and economic growth. We will also review the evolution of unemployment rates and economic growth in Algeria.

2.1. The concept of unemployment:

Unemployment is an economic and social phenomenon that reflects the presence of individuals within the working age population who have the ability and desire to work, but have difficulty finding suitable job opportunities. In other words, unemployment refers to the lack of job opportunities for people who seek a job and meet employment requirements. In other words, it refers to a situation in which an individual actively seeks employment, but does not succeed. Unemployment is a key indicator of an economy's health. The most commonly used indicator is the unemployment rate, which is calculated by dividing the number of unemployed people by the number of active individuals in the labor market (HAYES, 2025).

Unemployment is also defined as the failure to contribute to production in a compulsory manner. The term 'unemployment' also refers to the underutilization of economic resources in economic activity, such as the non-exploitation of natural resources, the idle use of resources involved in the production of goods and services, or labor that does not contribute to various economic activities.

2.1.1. The concept of unemployment according to the International Labour Office: According to the International Labour Office (ILO), the category of unemployed individuals consists of every person between the ages of 16 and 60 years provided they meet three conditions:

•Being without work, meaning that they did not engage in any activity for a cash or in-kind wage, even one hour in the week preceding the day of the census or survey;

•In a state of seeking a job, meaning that they have searched for work once or several times, by submitting employment applications during the week preceding the first day of the census or survey

•It should also be available,

2.1.2. The concept of unemployment according to the National Office of Statistics: According to the National Office of Statistics (NOS), unemployment is limited to that category of persons within a working age population who are unemployed for even an hour during the reference period and declare that they are looking for work and are divided into two categories:

• The first category (STR1): Unemployed persons who have previously worked and then returned to unemployment, to be considered unemployed due to dismissal, resignation or expiry of the contract period...etc.

• The second category (STR2): They are unemployed people who have never worked, either because they are a new category belonging to the active population by virtue of age or they have found difficulties in finding jobs and thus they are looking for their first job.

2.1.3. How to calculate the unemployment rate: The unemployment rate is one of the macroeconomic indicators of great significance in designing economic policies and evaluating their effectiveness. The problem of unemployment cannot be addressed unless there is a real perception of it. The unemployment rate also reflects the inefficiency of the labor market in utilizing the entire available labor force and is given by the following relationship:

$$\text{UPR} = \frac{\text{Number of Unemployed People}}{\text{Total labour force}} * 100$$

2.2. The concept of economic growth:

GDP is a measure of the monetary value of final goods and services, that is, those purchased by the end-user, that were produced in a given country during a specified period of time (such as a quarter or a full year); this measure includes all production that takes place within the borders of the country; GDP consists of goods and services intended for sale in the market, and also includes a portion of non-commercial production, such as defense or educational services provided by the government. On the other hand, GNP is defined as the calculation of the total production carried out by the population of the country and therefore, if an Algerian company owns a factory in the United States, the production of this factory will be counted in the US GDP, while it is included in the Algerian GDP (Callen).

Economic growth is defined as the increase in the amount of goods and services produced by a particular economy over a specific period of time. These goods are produced using the factors of production, namely land, labor, capital and organization. It is also defined as a positive change in the level of production of goods and services in a country in a certain period of time, that is, an increase in the income of a particular country. This increase is usually measured by GDP or Gross National Product (GNP). Economic growth reflects the expansion of the productive capacity of the economy and is one of the key indicators for improving the standard of living and economic well-being. It is given by the following:

$$EGR = \frac{GDP_t - GDP_{t-1}}{GDP_{t-1}} * 100$$

2.3. Relationship between economic growth and unemployment:

The relationship between economic growth and unemployment is complex and has a reciprocal effect. Overall, economic growth is a vital factor in reducing unemployment. When the economy is growing, demand for labor rises, contributing to lower unemployment. On the other hand, high unemployment can negatively affect economic growth, as this leads to a decline in consumer spending, which negatively affects corporate revenues, and the general trend in this relationship is that there is a significant correlation between high economic growth rates and low unemployment rates (Helge Berger ; Martin Schindler, 2014).

The high rate of economic growth is determined by the nature of the economic policy adopted. Keynesian analysis focuses on the policy of recovery by demand, which is often the prevailing belief among most economists, considering that unemployment will automatically decrease if economic growth rates rise, while another, more liberal trend focuses on supply by supporting the profitability and efficiency of projects. However, it is noticeable that there is a great correlation between growth and changing unemployment rates. High growth rates indicate that the economy needs additional labor to be employed from the surplus of the labor market formed in previous periods. On the other hand, a recession that usually corresponds to low or negative growth rates indicates an increase in unemployment rates due to job losses, while a slowdown in the economy leads to a decrease in the creation of new jobs below the normal level at which unemployment is supposed to begin to decline.

This theoretical analysis of the relationship between growth and the change in the unemployment rate can be considered a natural and logical analysis, but what limits the value of this analysis is the lack of proportionality between growth rates and unemployment rates. The rise in economic growth by 2% does not necessarily lead to a decrease in the unemployment rate by 2%. We also find that the same economic growth rates do not have the same impact on unemployment in all countries. (MUET, 1997)This shows the extent to which the growth achieved can affect unemployment through econometric analysis. Okun's law refers to the relationship between economic growth and the rate of change of unemployment, so that unemployment was considered to be a decreasing proportion in relation to the rate of potential or natural economic growth achieved by an economy. Okun showed in the early 1960s that unemployment rises whenever real growth (real GDP) falls below the level of potential growth (potential GDP), which was known as the Okun gap (OKUN, 1962).

Okun Arthur established a linear relationship between economic growth, measured by the real GDP growth rate, and the change in the unemployment rate. This rule indicates that there is a minimum level of economic growth, and if growth falls below this limit, the unemployment rate rises, while it decreases when it exceeds this limit, accordingly, the high unemployment rate in the United States, by 1%, is associated with a decrease of about 3% in real GDP. This means that to reduce unemployment, the economy must grow at a rate that exceeds its natural growth rate, which includes increasing the number of the workforce and improving productivity.

This relationship consists in reducing the difference between the actual GDP and its potential level, leading to a reduction in unemployment. When talking about National (or Domestic) output, we must distinguish between actual GDP and potential GDP. The actual output is the value of goods and services produced by a society during a certain period of time. Potential output is the level of production estimated based on the full employment of all factors of production (land, labor, capital, and organization. The total imbalance in the economy (the output gap) occurs if the balance level of output (income) is greater or less than the possible output level. It shows that when economic growth is below a certain level, the unemployment rate rises, while it decreases when it exceeds this level. Thus, the Okun coefficient can be determined for each growth point that exceeds this limit, which varies from country to country and from one period of time to another. Therefore, economic policies aim to promote growth in jobs, leading to a reduction in this limit (VERNE, 2007).

Okun interpreted the relationship between unemployment and economic activity in two different ways (OKUN, 1962):

- The first formula (the first differences formula) relates the change in unemployment (Δu) to the change in GDP (Δpib), which is given by the following relationship:

$$\Delta u = c + \beta \Delta pib + \varepsilon \dots\dots\dots\dots\dots (01)$$

Where Δ is the first difference of the variable, the unemployment u rate, pib is the logarithm of the real GDP and β measures the change of the unemployment rate in percentage when the real GDP changes by 1%.

- The second formula (gap formula): shows the relationship between the difference in the actual unemployment rate and its natural level and the difference between the actual GDP and its possible level and is given as follows:

$$u - u^* = c + \beta^*(pib - pib^*) + \varepsilon \dots\dots\dots\dots\dots (02)$$

They represent, respectively,u^*,pib^* the natural unemployment rate and the possible gross domestic product. The difference between ($pib - pib^*$) is called the output gap. β^* The Okun coefficient measures the amount of change in the periodic unemployment rate when the production difference changes by 1%. Econometric studies conducted on this model confirm that there are differences between countries in the field of increasing the economic growth rate, as the Okun coefficient for the European Union is determined collectively in the range of 0.32- and 0.36- in the euro area, which means the need to achieve growth of 3% to reduce unemployment by 1% for these countries (KOREM, 2021, p. 130).

2.4. Unemployment and economic growth in Algeria:

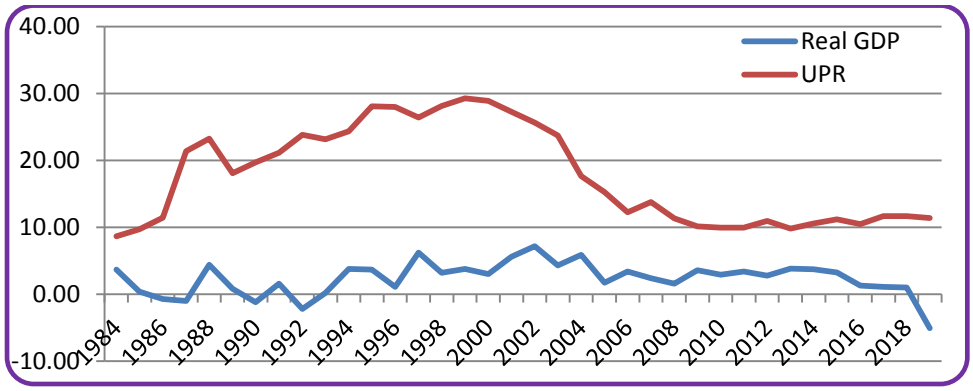
The rate of real economic growth during the period 1980 to 1984, which relates to the first five-year plan, saw a marked increase as a result of higher oil prices. The average real economic growth rate in that period exceeded 4.2%, peaking at 7% in 1984. Meanwhile, unemployment fell below 13.5%, hitting a record low of 8.7% thanks to remarkable economic growth resulting from public industrial investments, and restructuring focused on consumer-oriented industries, which created jobs between 1980 and1985 at an average annual rate of 13.9%.

However, the global oil crisis in 1986 had a significant impact on economic growth, with the average annual growth rate dropping from more than 4% during the first five-year plan to 1.20% in 1986, and then to -0.81% in 1987. These rates did not recover until after oil prices rose as a result of the second Gulf War in 1990. Arguably, during the period that coincided with the second five-year scheme, unemployment rates rose significantly to 18.5% in 1989 (BENMERIEM , Mohammed; BENSAFTA, Kamel Malik ; BARIK, Mourad, 2023, p. 123).

This increase in the unemployment rate during this phase can be explained by the decline in external resources, which led to the deterioration of GDP and the implementation of market reforms, as the 1990s were characterized by a transition towards a market economy, and the country faced significant macroeconomic challenges that led to the emergence of noticeable imbalances in the labor market. The number of new jobs in the productive public sector decreased as a result of the economic downturn. In contrast, the industrial sector witnessed a significant decline as a result of the reform and structural adjustment programs that Algeria began to

implement after 1994, in addition to the start of the privatization process that affected economic institutions, albeit at a slow pace.

Fig N° 1: Evolution of unemployment rates and real GDP



Source: Based on Ministry of Finance data.

These measures combined to reduce employment opportunities in the industrial sector, while the phenomenon of employment in the informal sector emerged, and the unemployment rate increased to include university degree holders, where unemployment peaked in 1999 to reach more than 29%. At the same time, the economic growth rate has witnessed a decline, as it recorded negative values between 1993 and1994, before rising to 4.1% in 1995, and then falling to 1.9% and1.13% in 1996 and1997, respectively, as a result of the decline in the production of the agricultural sector due to drought and lack of exploited areas. Thus, the period witnessed a decline in the economic growth rate to an average of 1.6% (Bouyacoub, 1997, p. 5).

The second millennium saw a marked increase in oil prices, which had a positive impact on growth rates that sometimes exceeded 5%, and unemployment rates fell below 10% in late 2014. This is due to the development programs adopted by the state through increasing public spending that included all sectors, which contributed to absorbing a large part of the surplus of the labor market. This was achieved thanks to the increase in public expenditures, especially in the construction and public works sector, in addition to various programs to support job creation (such as ANSEJ, CNAC and ANGEM), as well as programs to integrate new job seekers (such as subsidized employment contracts) (NOS, 2021).

In the period from 2015 to 2019, we have witnessed an increase, albeit timid, in the unemployment rate, with a trend towards deterioration in the quality of jobs (unregistered jobs, informal jobs) and an increasing number of jobs that do not require high qualifications, while the number of job-seeking learners is increasing significantly. Economic indicators indicate a decline in GDP of 5.07% in 2020 compared to 1.01%, as the unemployment rate rose to 11.43% compared to 11.30% in 2019 as a result of the health crisis (Covid-19 pandemic) (NOS, 2021), which led to a sharp decline in the volume of production and loss of jobs and income. The pandemic period has been in a state of uncertainty for a long time, and optimism only began to return with the announcement of the

discovery of potential corona virus vaccines, raising hopes for an economic recovery. Economic activity in Algeria experienced a remarkable recovery in 2021, registering a growth rate of 3.5% in 2022 (Central Bank , 2022).

3. Methodology of the study

In this study, we rely on two methods of economic measurement, namely the Autoregressive Distributed Lag (ARDL), a modern methodology developed by Pesaran (1997), Shindand and sun (1998), and Pesaran and AL (2001). The least squares method with periods (LS with Breakpoints).

3.1. ARDL Form (Pesaran, M.H, Shin,Y., Smith,R.J,, 2001):

The ARDL model is an econometric teacher technique used to test the long-term relationship between variables that are not integrated of the same degree. This technique is characterized by giving the best estimate of the parameters in small samples, as it is considered the best models suitable for small sample size. The reason for choosing this model compared to other methods of joint integration testing is that the two-time series under study are not complementary to the same degree. According to PESARAN, the border test can be applied in the framework of ARDL regardless of the characteristics of the time series if they are stable at the level ($I(0)$) or first degree integration ($I(1)$) or a mixture between them; To estimate the long-term relationship between unemployment and economic growth in Algeria and based on Equations (01) and (02), we use the ARDL model, defined as follows:

$$\Delta \text{chom}_t = \mu + \sum_{i=1}^{p} \delta_{1i}\, \Delta \text{chom}_{t-i} + \sum_{i=1}^{p} \delta_{2i}\, \Delta \text{gap}_{t-i} + \gamma_1 \text{chom}_{t-1} + \gamma_2 \text{gap}_{t-1} + \varepsilon_t \qquad 03$$

Where: γ_1, γ_2 are the two parameters of the long-term relationship between the variables, Δchom_t is the first difference, is the difference between unemployment and natural unemployment, gap_{t-i} is the difference between real GDP and potential GDP.

According to this equation (03), the long-term relationship exists between the two variables if the coefficients (γ_1 and γ_2) are statistically significant, so that the co-integration hypothesis is tested using the Fisher test, which compares the calculated value with the values given in the statistical tables set by PESARAN and AL (2001), so that the hypothesis of the absence of co-integration (H_0) is rejected if the calculated value of Fisher's statistic is greater than the tabulated value.Okun's long-term coefficient is given by the following relationship:

$\beta = -{}^{\gamma_2}/_{\gamma_1}$.

3.2. Estimation by the method of least squares at intervals (LS with Breakpoints):

Structural change analysis is a key issue in econometrics, as many political and economic factors can lead to changes in the relationships between economic variables over time. Bai and Perron (1998) studied the estimation of multiple structural intervals in the linear least squares model and proposed tests to detect

structural changes in the absence of regression trends, as well as a selection procedure based on a series of tests aimed at continuously estimating the number of discontinuity points (Gülcan, 2005, p. 90).

This method is mainly based on dividing the studied period into intermittent periods based on the structural change test (Breakpoints). The parameters are estimated by the normal least squares method in each of the specified periods. Techniques such as the chow or Bai-Perron test are used to determine these periods. The reason for adopting the least squares method at intervals (BLS) is that the two time series used in the study are characterized by changes and external structural fluctuations that affect them, in addition to the fact that the application of the ordinary least squares method is given and biased despite the changes and external shocks that occur on the chain, and therefore the forecasting process does not take into account these changes, while the BLS method gives variable estimates according to periods (Achim Zeileis [aut, cre],, 2024). Therefore, in the case of forecasting, you only take estimates for the period immediately preceding the forecasting period (Startz, 2015).

3.3. Description of Data:

The studyused quantitative data that includes annual time series, including annual unemployment rates as a percentage, and economic growth rates measured by GDP in Algeria, during the period from 1984 to 2020. This data was collected from the databases of the Ministry of Finance and the National Office of Statistics, and processed to deal with missing values and convert them into percentages.

3.4. ARDL Model Estimation:

The stability of the two series (chom and pib_réel) was tested using the ADF test and we found that the chom series and the pib_réel series are first-order integrals (see Appendix).

To estimate the model, we use Equation (03) as follows:

$$\Delta gap_t = c + \sum_{i=1}^{p} \delta_{1i}\, gap_{t-i} + \sum_{i=1}^{p} \delta_{2i}\, \Delta(gap\_pib)_{t-i} + \gamma_1 gap_{t-1} + \gamma_2 (gap\_pib)_{t-1} + \varepsilon_t \qquad 04$$

3.4.1. Definition of variables :

chom	Unemployment rate
Pib_réel	Real GDP in 2000
Chom_n	Unemployment rate
Pib_p	Gross Domestic Product
gap	Difference between Unemployment Rate and Natural Unemployment Rate
gap_pib	Difference between Real GDP and Latent GDP

The natural unemployment rate (chom_n) and potential Gross Domestic Product (pib_p) series were obtained

using the Hodrick-Prescott filter technique.

We conducted an estimation of a series of ARDL models and identified the optimal model based on two criteria: firstly, the values of the information criteria (AIC, SIC, HQC), which indicated the lowest value for the latter; and secondly, the significance of the estimated coefficients of the model, where all coefficients deemed insignificant were systematically removed. Models that failed to satisfy the prerequisites for the application of the Okun model were discarded, while the ARDL(8,7) model was preserved. The results of the estimation were recorded in Table (01).

Table N°1: Results of estimating the ARDL model (8,7)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.064165	0.152048	-0.422001	0.6812
GAP(-1)	-1.115096	0.197002	-5.660334	0.0001
GAP_PIB(-1)	-2.53E-05	8.02E-06	-4.268933	0.0015
D(GAP(-1))	0.494888	0.201137	2.460357	0.0317
D(GAP_PIB(-1))	9.40E-06	6.54E-06	1.437410	0.1784
D(GAP(-2))	0.764876	0.207769	3.681385	0.0036
D(GAP_PIB(-2))	1.25E-05	6.09E-06	2.053130	0.0646
D(GAP(-3))	0.215556	0.185442	1.162387	0.2697
D(GAP(-4))	0.343170	0.108411	3.165459	0.0090
D(GAP_PIB(-4))	1.49E-05	4.37E-06	3.407241	0.0059
D(GAP(-5))	0.355951	0.122328	2.909813	0.0142
D(GAP(-8))	0.199780	0.099103	2.015875	0.0689
D(GAP_PIB(-7))	4.71E-06	3.21E-06	1.468706	0.1699
D(GAP_PIB(-5))	6.29E-06	3.24E-06	1.938978	0.0786
D(GAP_PIB(-3))	2.26E-05	4.82E-06	4.687208	0.0007
R-squared	0.913544	Mean dependent var		0.040302
Adjusted R-squared	0.803510	S.D. dependent var		1.544390
S.E. of regression	0.684585	Akaike info criterion		2.373637
Sum squared resid	5.155224	Schwarz criterion		3.099462
Log likelihood	-15.85729	Hannan-Quinn criter.		2.582649
F-statistic	8.302345	Durbin-Watson stat		1.717907
Prob(F-statistic)	0.000596			

Source: Using Eviews13.

Before interpreting the estimated ARDL model (8,7) we conduct a Bounds Test to examine the existence of a cointegration relationship among the studied variables. When multiple integrated variables of varying orders (I(0), I(1)) are present, the cointegration test formulated by Pesaran et al. (2001), commonly referred to as the 'bounds test for cointegration', which was initially introduced by Pesaran and Shin (1999), can be employed. If Pesaran's cointegration test is utilized to ascertain the presence of one or more cointegration relationships among variables within an ARDL model, this is termed the 'ARDL approach to cointegration' or the implementation of the cointegration test utilizing staggered lags.

The testing procedure entails comparing the Fisher statistics derived with the critical values (boundaries) that have been simulated for various scenarios and different thresholds by Pesaran et al. It is important to highlight that the critical values for the upper boundary encompass the values corresponding to variables integrated of order 1, I(1), whereas the lower boundary pertains to the I(0) variables.

Table N°2: Bounds test to cointegration

F-Bounds Test		Null Hypothesis: No levels relationship		
Test Statistic	Value	Signif.	I(0)	I(1)
		Asymptotic: n=1000		
F-statistic	5.216842	10%	3.02	3.51
k	1	5%	3.62	4.16
		2.5%	4.18	4.79
		1%	4.94	5.58
Actual Sample Size	38	Finite Sample: n=40		
		10%	3.21	3.73
		5%	3.937	4.523
		1%	5.593	6.333
		Finite Sample: n=35		
		10%	3.223	3.757
		5%	3.957	4.53
		1%	5.763	6.48

Source: Using Eviews13.

According to Table No. 2, it is observed that $F_c = 5.216842$ exceeds the upper bound (4.16) for α=0.05. Consequently, this indicates the existence of a long-term equilibrium relationship between the studied variables.

The results of the estimation indicate the availability of the Okun model acceptance conditions for the statistical significance of the coefficients of the two variables according to the Student test, from which we can recognize the relationship between unemployment and long-term growth. The Okun (β) coefficient was estimated at -2.53e^{-5} which means that on average, a 1% higher GDP growth rate leads to a -2.53e^{-5}% lower unemployment rate.

From this, we conclude that there is a relationship between unemployment and economic growth in Algeria, but it is weak with a slow response. Statistically, the estimated model is acceptable, according to Fisher's statistics ($Prob < 0.05$), which indicates that the model was well formulated, and the corrected coefficient of determination was 80%, which indicates that the production gap explains the unemployment gap well. Most of the parameters of the interpreted variables are characterized by a significance that far exceeds this tabular value. Econometrically, random errors came naturally distributed in the estimated model, as the Jarque and Bera test gave a value equal to 1.4970 with a probability of 0.473 ($Prob > 0.05$), and the model also does not suffer from the problem of autocorrelation of errors, as the Breusch-Godfrey test gave *a* probability greater than 0.05 ($Prob = 0.201$) and therefore the errors are independent among them. As for the heteroscedasticity test, the Breusch-Godfrey test was used to test for homogeneity of errors. *The* latter refers to the homogeneity of error variation throughout the study period, and this was confirmed by a statistic with a $F = 1.267$ probability greater than 0.05($Prob = 0.301$). The estimated model has successfully passed all statistical and econometric tests, which allows us to go to the forecasting stage**.**

3.4.2. Forecasting stage: At this stage, we predict unemployment rates for the next four years, as the forecast period was set from 2021 to 2024; this period was chosen because of the lack of data (values) of unemployment rates, as the National Bureau of Statistics did not publish the latter.

3-4-2-1-Prediction Hypotheses:

The first hypothesis: The data of economic growth estimates (reel Pib) for the forecast period provided by the Ministry of Finance (General Directorate of Assessment and Policy) were used. On the basis of the latter, we estimated the real and potential GDP.

The second hypothesis: Estimates of natural unemployment in the forecast period were given using the 10-year moving averages method.

3.4.2.2. Forecasting results: The results of forecasting unemployment rates in Algeria came from the ARDL model as shown in Table (03). The fourth column is the predicted unemployment values.

Table (03): The prediction results of the ARDL model

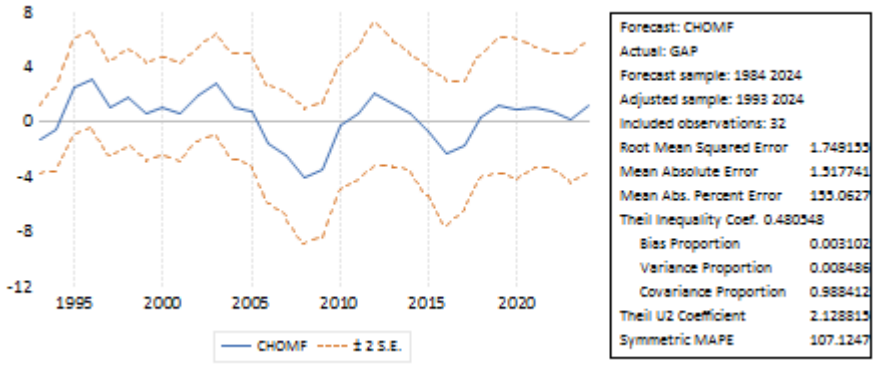
dispute	GAP	N	chomf
2021	1.08	10.49	11.57
2022	0.77	10.45	11.26
2023	0.18	10.51	10.69
2024	1.24	10.48	11.72

Source : by Excel

Following the prediction of unemployment rates in Algeria, it is essential to evaluate the precision of the forecast by employing Theil's criterion. Although there exist additional metrics for assessing forecast accuracy (RMSE, MAPE, MAE), these are generally employed to evaluate several predictive models (Hyndman, 2021), and consequently, they are not relevant to our study since we utilized only a single model for prediction.

Figure N^{0}2 clearly shows that the Theil index is close to zero (U = 0.48), indicating a strong prediction. Theoretically, a Theil index close to zero (U = 0) means a more accurate prediction, while a value close to one (U = 1) reflects a less accurate prediction.

Fig N° 2: Confidence interval for forecasted unemployment rates



Source: Using Eviews13

3.5. Estimating the BLS model:

After estimating the relationship between unemployment rates and economic growth according to the Okun model through the ARDL model, we will estimate at this stage the relationship between the two variables in the least squares method at intervals.

This method allowed dividing the studied period into three periods based on the Breakpoints test. In order to obtain the elasticity of unemployment in relation to growth, we decided to enter the logarithm on the two series. With negative values of the volume of GDP, we added the number 100 to all values to avoid negative values. The model was formulated as follows:

$$l(cho_{100}) = c + \alpha_1 l(pibhh_{100}) + \alpha_2 l(cho_{100})_{t-1} + \alpha_3 l(pibhh_{100})_{t-1} + \varepsilon_t$$

3.5.1. Definition of variables :

Pib hh	Volume of GDP outside hydrocarbons
Pib hh_100	Volume of GDP outside hydrocarbons at the base of 100
Cho	Unemployment rate
Cho_100	Unemployment rate at the base of 100

The results of the estimated model (see Table No. (04)) were statistically acceptable, according to Fisher's statistics, and it is $Prob < 0.05$ an indication that the formulation of the model was correct, and the corrected coefficient of determination was 95%, which indicates that the real GDP outside hydrocarbons explains the unemployment rates by 95%, and most of the parameters of the interpreted variables are characterized by a significance that greatly exceeds the scheduled value; random errors are distributed naturally, as the Jarque and Bera test gave a value equal to 2.556 with a probability of 0.278 ($\text{Prob} > 0.05$). The model does not suffer from the problem of autocorrelation of errors, as the Breusch-Godfrey test gave a probability greater than 0.05 ($\text{Prob} = 0.089$) with an estimated value of 2.448, so the errors are independent of each other.

Table (04): BLS Model Estimation Results

Dependent Variable: LCHO_100
Method: Least Squares with Breaks
Date: 04/16/25 Time: 09:38
Sample (adjusted): 1985 2020
Included observations: 36 after adjustments
Break type: Bai-Perron tests of L+1 vs. L sequentially determined breaks
Breaks: 1990, 2004
Selection: Trimming 0.15, Max. breaks 4, Sig. level 0.05

Variable	Coefficient	Std. Error	t-Statistic	Prob.
1985 - 1989 — 5 obs				
C	12.31667	3.405538	3.616659	0.0014
LPIBHH_100(-1)	-5.416500	1.176993	-4.601981	0.0001
LCHO_100(-1)	0.761290	0.160814	4.733962	0.0001
LPIBHH_100	-1.887900	1.819902	-1.037363	0.3099
1990 - 2003 — 14 obs				
C	1.751978	1.030676	1.699834	0.1021
LPIBHH_100(-1)	0.327844	0.642989	0.509874	0.6148
LCHO_100(-1)	0.825689	0.192768	4.283341	0.0003
LPIBHH_100	-0.919121	0.750566	-1.224571	0.2326
2004 - 2020 — 17 obs				
C	2.620203	0.987379	2.653695	0.0139
LPIBHH_100(-1)	-0.151894	0.664661	-0.228529	0.8212
LCHO_100(-1)	0.545165	0.112015	4.866875	0.0001
LPIBHH_100	-0.159391	0.662010	-0.240768	0.8118

R-squared	0.965939	Mean dependent var	4.767314
Adjusted R-squared	0.950328	S.D. dependent var	0.060418
S.E. of regression	0.013465	Akaike info criterion	-5.516178
Sum squared resid	0.004352	Schwarz criterion	-4.988338
Log likelihood	111.2912	Hannan-Quinn criter.	-5.331947
F-statistic	61.87449	Durbin-Watson stat	2.659836
Prob(F-statistic)	0.000000		

Source: Using Eviews13

As for the heteroscedasticity test, the Breusch-Godfrey test was also used. The latter indicates the homoscedasticity of error variation throughout the study period, and this was confirmed by a statistic with a $F = 2.302$ probability greater than 0.05 ($Prob = 0.129$).

The estimated model was subjected to statistical and econometric tests and met all the admission requirements, from which we can pass to the forecasting stage.

3.5.1. Forecasting phase: It is the process of forecasting unemployment rates in Algeria between 2021 and 2024. Variable values of non-hydrocarbon GDP (pibhh) for the forecast period were obtained from the Directorate General of Estimation and Policy (Ministry of Finance). Table (05) gives us the results of the forcast.

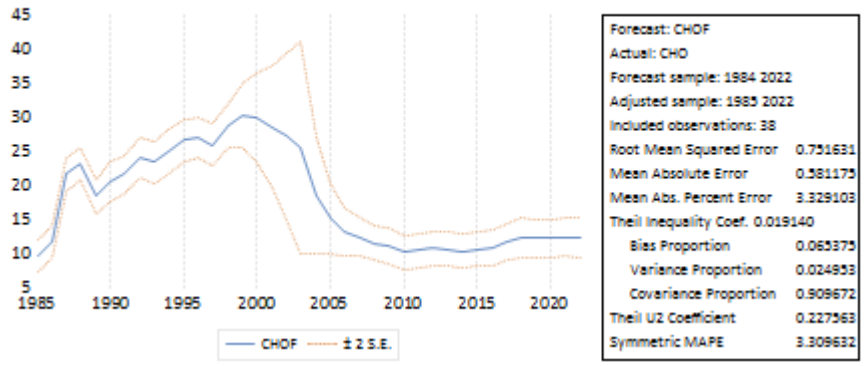
Table (05): forcast results of the BLS model

Years	Pibhh_100	CHO	chof
2021	4	112	12.12
2022	4	111	11.82
2023	4	111	11.51
2024	4	111.41	11.41

Source: by Excel

The graph N°3 clearly indicates that the Theil index is near zero (U = 0.019), suggesting a robust forcasting of unemployment rates in Algéeria. In theoretical terms, a Theil index approaching zero (U = 0) signifies a higher accuracy in prediction, whereas a value nearing one (U = 1) denotes a lower accuracy in prediction.

Fig N° 3: Confidence interval for forecasted unemployment rates



Source: Using Eviews13

4. Results and discussion

Through the applied study of the ARDL and BLS models, we found that the relationship between unemployment and economic growth is fluctuating, as the inverse relationship was achieved in 2019 and 2021, while it was not achieved in 2020 and 2022, which are logical results compared to the actual values achieved.

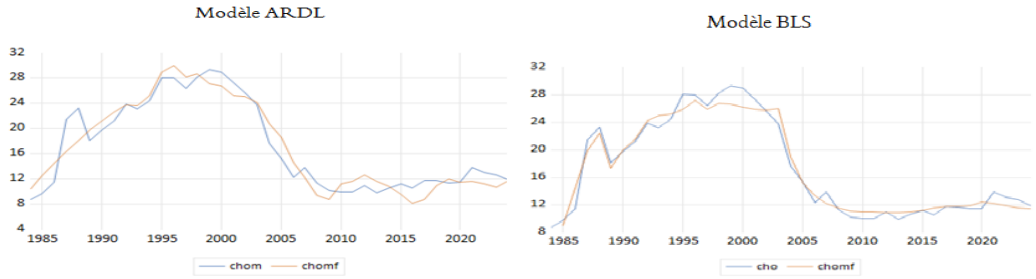
Table (06): Comparison of forecasts

	chof ARDL	chof BLS	chofComb	pibhh
2021	11.57	12.12	11.85	3.61
2022	11.26	11.82	11.54	5.62
2023	10.69	11.51	11.10	4.74
2024	11.71	11.41	11.56	5.10

Source: Excel

Table No. (06) summarizes the results of forecasts of unemployment rates and compares them with the real GDP outside hydrocarbons, which we obtained through the quantitative methods used in the study in addition to calculating the average of the two values forecasted in each year (the fourth column), which is a technique that allows combining the results reached by the two methods used (ARDL, BLS).

Fig N° 4: The true chain path forecasted in the two models



Source: Using Eviews13

Through Table (05), we note that the forecasting values of the BLS model decrease year after year, while the values of unemployment rates forecasted by the ARDL method fluctuate between 10% and %11. We supported these results with a graph of the two series predicting their values in the four years.

5. Conclusion:

This study aims to apply some quantitative methods to the relationship of unemployment to economic growth in Algeria and forecast it in the future, Horizon 2024, as the statistical data for these two variables were taken from the database of the National Bureau of Statistics from 1984 to 2020, where we estimated the best model that meets the statistical and econometric conditions in both ways (ARDL and BLS) that allowed us to forecast the values of unemployment rates in Algeria, **which leads us to accept the third hypothesis** and formulated as follows: "Historical data on unemployment in Algeria provides a sufficient basis for building reliable predictive models." Through the applied study of the ARDL and BLS models, we found that the

relationship between unemployment and economic growth is fluctuating, as the inverse relationship was achieved in 2019 and 2021, while it was not achieved in 2020 and 2022, which are logical results compared to the actual values achieved, from which **we accept the second hypothesis**, which is "There is a statistically significant relationship between unemployment rates and economic growth." We also found through the results of the application of the ARDL model that the predictive values of the latter achieve economic theory, while the results of the application of the BLS model are contrary to economic theory, but they are in line with the Algerian economic reality, which **confirms** the **first hypothesis** that "quantitative methods (such as the ARDL and Breakls) can be used to accurately forecast unemployment rates in Algeria."

Here we refer to the difficulty of decision-making by officials. The question posed in this case by decision-makers is what is the optimal model that we can take as a basis for prediction? To answer this question, we propose some recommendations that may enable decision-makers to take the necessary decisions to solve economic problems by using econometric methods and models for forecasting, allowing them to develop plans and programs to confront the threats that the national economy suffers from, through scenarios:

-The first scenario (optimism scenario): We recommend applying and taking the results of the ARDL model for optimists because it is in line with economic theory and ignores the contradictions that exist in reality.

- The second scenario (pessimism scenario): We recommend applying and taking the results of the BLS model for pessimists, whose results were in line with reality and ignored economic theory.

- The third scenario (a viewpoint for statisticians) We recommend the technique of combining the two models (JAMES H. STOCK, AND MARK W. WATSON, 2004, p. 23), and predictive values can be taken for each year separately, that is, according to economic theory and its compatibility with the current economic reality.

The relationship between unemployment and economic growth is complex and varies greatly according to economic policies, labor market structures, and other contextual economic variables. However, relying on quantitative methods in estimating the relationship between unemployment rates and economic growth allows the identification of an econometric model that explains this relationship and enables it to be relied upon in the process of predicting future unemployment rates.

6. List of references:

- Achim Zeileis [aut, cre],. (2024, 09 02). *strucchange: Testing, Monitoring, and Dating Structural Changes.* Retrieved 02 27, 2025, from https://cran.r-project.org/web/packages/strucchange/strucchange.pdf?
- BENMERIEM , Mohammed; BENSAFTA, Kamel Malik ; BARIK, Mourad. (2023). CROISSANCE ÉCONOMIQUE ET TAUX DE CHÔMAGE. *Les Cahiers du Cread , 39* (04), 117-143.

- Bouchenaki, F., & Fekir, H. (2021). La relation entre chômage et croissance économique en Algérie : une étude. *Revue des sciences humaines de l'université Oum El Bouaghi , 8* (2), 1435-1449.
- Bouyacoub, A. (1997). La difficile adaptation de l'entreprise aux mécanismes de. *Les Cahiers du Cread* , 5-11.
- Callen, T. (s.d.). *PRODUIT INTÉRIEUR BRUT : UNE ÉCONOMIE, C'EST TOUT*. Consulté le 01 20, 2025, sur Fonds monétaire international: https://www.imf.org/en/Publications/fandd/issues/Series/Back-to-Basics/gross-domestic-product-GDP
- Central Bank . (2022, 06). *RAPPORT ANNUEL 2021 EVOLUTION ECONOMIQUE ET MONETAIRE EN ALGERIE.* Consulté le 01 20, 2023, sur https://www.bank-of-algeria.dz/publications-page/
- Gülcan, Ö. (2005). TESTING FOR MULTIPLE STRUCTURAL BREAKS: AN APPLICATION OF. *D.E.Ü.İİ.B.F. Dergisi* , 90.
- HAYES, A. (2025, 01 28). *Guide du chômage*. Consulté le 02 17, 2025, sur investopedia: https://www.investopedia.com/terms/u/unemployment.asp
- Helge Berger ; Martin Schindler. (2014, Mars). *Lourde menace sur la croissance*. Consulté le 12 20, 2024, sur Finances & Développement: https://www.imf.org/external/pubs/ft/fandd/fre/2014/03/pdf/berger.pdf
- Huang, H., Lin, S. (2008). Smooth-Time-Variyng Okun's Coeffcient. *Science Direct Economic Modelling* (25), 363-375.
- Hyndman, R. J. (2021). *Forecasting: Principles and Practice* . OTexts.
- JAMES H. STOCK, AND MARK W. WATSON. (2004). Combination Forecasts of Output Growth in a Seven-Country Data Set . *Journal of Forecasting,J. Forecast* , 405–430.
- KOREM, A. L. (2021). CROISSANCE ECONOMIQUE ET CHOMAGE : EVIDENCE EMPIRIQUE DE LA LOI D'OKUN DANS LES PAYS DE L'UEMOA. *REVUE ECONOMIQUE ET SOCIALE AFRICAINE* , pp. 126-162.
- MUET, P.-A. (1997, 04). *DEFICIT DE CROISSANCE ET CHOMAGE .* Consulté le 12 20, 2024, sur institutdelors.eu: https://institutdelors.eu/wp-content/uploads/2018/01/probl1-pamuet-deficitdecroissance-fr.pdf
- NOS. (2021). *Activité industrielle 2011-2020, numéro 110.* Consulté le 1 14, 2023, sur https://www.ons.dz/IMG/pdf/industrie2011-2020.pdf
- OKUN, A. (1962). Potential GNP : its measurement and significance. *Proceedings of the Business and Economic Statistics Section of the American Statistical Association* , 98-104.
- Pesaran, M.H, Shin,Y., Smith,R.J,. (2001). Bounds Testing Approaches to the Analysis of Long-run Relatio,ships. . *Journal of applied econometrics* , 289-326.
- Startz, R. (2015). Illustrated for Eviews, version 9, . Editors Meredith Startz and HIS global Inc.
- VERNE, J.-F. (2007). LA CAUSALITE ENTRE LA CROISSANCE, LE CHOMAGE ET LES IMPOTS : UNE ANALYSE REVISITEE DE LA LOI D'OKUN. *CAHIERS ECONOMIQUES DE BRUXELLES* , 363.

- عباس فؤاد عباس حسن. (2020). أثر النمو الاقتصادي على البطالة -دراسة حالة المملكة العربية السعودية خلال الفترة 1980-2018. *مجلة العلوم الاقتصادية والقانونية والادارية ، 4* (6)، 17-31.

7. Appendices:

The results of the stability of the two series after the differences are made.

Null Hypothesis: DTCHOM has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=8)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.455166	0.0001
Test critical values:	1% level	-2.636901	
	5% level	-1.951332	
	10% level	-1.610747	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(DTCHOM)
Method: Least Squares
Date: 03/09/25 Time: 14:28
Sample (adjusted): 1986 2018
Included observations: 33 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
DTCHOM(-1)	-0.763508	0.171376	-4.455166	0.0001

Null Hypothesis: D(PIB_REEL) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.234412	0.0019
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(PIB_REEL,2)
Method: Least Squares
Date: 04/16/25 Time: 10:30
Sample (adjusted): 1986 2024
Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(PIB_REEL(-1))	-0.654470	0.154560	-4.234412	0.0001
C	83519.75	26680.25	3.130396	0.0034