Measuring the impact of some economic variables On the unemployment rate in Algeria -an econometric study

قياس أثر بعض المتغيرات الاقتصادية على معدل البطالة في الجزائر –دراسة اقتصادية قياسية

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Abstract:

This study examines the impact of economic variables on the unemployment rate in Algeria. Using data from the World Bank's World Development Indicators, an ARDL model is estimated to capture both short- and long-run effects. The results indicate that GDP growth, inflation, and population growth significantly influence the unemployment rate in Algeria. In the short run, lagged values of the unemployment rate have a significant impact on the current rate, suggesting a dynamic adjustment process. In the long run, higher GDP growth and inflation are associated with higher unemployment, while population growth is inversely related to unemployment. The stability of the estimated coefficients is confirmed through the CUSUM and CUSUMSQ tests. Policy implications highlight the importance of promoting economic growth, controlling inflation, managing population growth, and maintaining stability for reducing unemployment in Algeria.

Keywords: Unemployment rate, ARDL model, GDP growth, inflation, population growth, Algeria.

JEL Classification Codes: J64, E24, J21.

ملخص:

تبحث هذه الدراسة في تأثير بعض المتغيرات الاقتصادية على معدل البطالة في الجزائر. تم استخدام بيانات من مؤشرات التنمية العالمية للبنك الدولي، وتم تقدير نموذج *ARDL* لاختبار التأثيرات على المدى القصير والطويل. أشارت النتائج إلى أن نمو الناتج المحلي الإجمالي والتضخم والنمو السكاني يؤثر بشكل كبير على معدل البطالة في الجزائر. كما أن القيم المتأخرة لمعدل البطالة لها تأثير كبير على المعدل الحالي في المدى القصير، مما يشير إلى عملية تعديل ديناميكية. أما على المدى الطويل فيرتبط ارتفاع نمو الناتج المحلي الإجمالي والتضخم بارتفاع معدلات البطالة، في حين يرتبط النمو السكاني عكسيًا بالبطالة. وتم تأكيد استقرار المعاملات المقدرة من خلال اختبارات *CUSUM* و*CUSUMSQ*. وأكدت الدراسة على أهمية تعزيز النمو الاقتصادي، والسيطرة على التضخم، وإدارة النمو السكاني، والحفاظ على الاستقرار للحد من البطالة في الجزائر.

كلمات مفتاحية: معدل البطالة، نموذج ARDL، نمو الناتج المحلي الإجمالي، التضخم، النمو السكاني، الجزائر.

تصنيفات JEL : J64، E24، J21.

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INTRODUCTION:

The unemployment problem has become a recurring economic issue of critical importance across the globe, and Algeria is no exception to this trend. Unemployment affects not only the socioeconomic well-being of individuals but also significantly impacts national economic growth, social stability, and development. The consequences of unemployment extend beyond economic difficulties, contributing to social issues like crime, inequality, and social unrest. As such, addressing unemployment is a high priority for policymakers, researchers, and economists alike.

In the case of Algeria, the unemployment rate has remained relatively high and persistent over the years. The effects of such high unemployment are far-reaching. On an individual level, it leads to income loss, while on a societal level, it can lead to increased poverty rates, crime, and social instability. Moreover, high unemployment rates could lead to the wastage of a country's human resources, hampering economic growth and development.

Despite the critical nature of this issue, a comprehensive understanding of the primary economic determinants of unemployment within the specific context of Algeria remains relatively limited. Prior research has explored this issue at a global level or within other national contexts, but the unique economic, demographic, and social attributes of Algeria necessitate a focused investigation.

The research problem this study seeks to address revolves around identifying and understanding the key economic variables influencing unemployment rates in Algeria. Specifically, this study explores the potential relationships between the unemployment rate and three primary economic indicators: GDP growth, inflation, and population growth. Understanding the nature and strength of these relationships is critical for formulating effective policies to mitigate unemployment.

Consequently, we propose the following hypotheses based on economic theory and previous empirical findings:

H1: GDP growth has a negative impact on the unemployment rate in Algeria. Economic theory suggests that as an economy grows and expands, more employment opportunities should be generated, potentially reducing the unemployment rate.

H2: Inflation has a positive impact on the unemployment rate in Algeria. High inflation can create uncertainty and instability in the economy, which could lead to slower job growth and, in turn, increased unemployment.

H3: Population growth has a positive impact on the unemployment rate in Algeria. Rapid population growth, particularly when it outpaces job creation, can lead to an increased supply of labor and hence higher unemployment rates, all else being equal.

To examine these hypotheses, we undertake an econometric analysis using annual data from 1991 to 2022. This timespan allows us to explore potential time series dynamics and cyclical patterns, providing a richer understanding of the evolution of the relationships over time.

By shedding light on the macroeconomic determinants of unemployment in Algeria, this study aims to contribute to the existing body of literature. Furthermore, it aspires to provide valuable insights for policymakers, allowing them to design effective strategies to combat unemployment and foster economic growth and development in Algeria.

1.Literature Review

Understanding the complex dynamics of unemployment and its determinants is crucial for policymakers, economists, and researchers seeking to address this persistent challenge. In this literature review, we explore the existing body of research on the macroeconomic determinants of unemployment, focusing on studies conducted in various contexts, as well as any relevant studies specific to Algeria.

1.1. GDP Growth and Unemployment:

The relationship between GDP growth and unemployment has been extensively studied in the literature. Several studies have found evidence of a negative correlation between GDP growth and unemployment, supporting the concept of Okun's Law. One study by Soylu et al. (2018) investigated the relationship between economic growth and unemployment in Eastern European countries. The study applied panel data analysis and found that a 1% rise in GDP led to a 0.08% decrease in the unemployment rate. The study also found a co-integration between economic growth and unemployment, suggesting a long-term relationship between these variables (Soylu et al., 2018). Similarly, Mandel & Liebens (2019) examined the correlation between GDP and unemployment in the US over a 50-year period. They used an econometric model and multiple regression analysis to test their hypothesis and found a continuously existing negative correlation between GDP and unemployment (Mandel & Liebens, 2019). Other studies have also supported the negative relationship between GDP growth and unemployment. Siddikee et al. (2022) confirmed the causal negative relationship between GDP growth rate and unemployment rate, based on a review of literature and empirical evidence (Siddikee et al., 2022; . Fairlie & Krashinsky, 2012) included growth rates in state GDP per capita and unemployment rates as control variables in their analysis of entrepreneurship, suggesting that local economic growth is correlated with entrepreneurship (Fairlie & Krashinsky, 2012). The concept of Okun's Law, which states that there is a negative relationship between aggregate unemployment change and GDP growth, has been widely discussed in the literature. Salehi et al. (2020) mentioned Okun's Law in the context of predicting macroeconomic indicators and the relationship between unemployment and GDP growth (Salehi et al., 2020). Similarly, Nicaise et al. (2013) included GDP growth as one of the control variables in their analysis of early school leaving (Nicaise et al., 2013) . Cho, (2021) also used GDP growth and unemployment rates as moderators in their analysis of social cohesion (Cho, 2021). In summary, the literature consistently supports the negative relationship between GDP growth and unemployment. Studies have used various econometric models and methods to analyze this relationship, and the findings consistently indicate that higher GDP growth is associated with lower unemployment rates. Okun's Law has been widely referenced in the literature as a theoretical framework for understanding this relationship.

1.2. Inflation and Unemployment:

The relationship between inflation and unemployment has been a topic of extensive research in the literature. Numerous studies have examined this relationship and have provided evidence of a connection between these two macroeconomic variables.

One study by Bernanke & Kuttner (2003) explored the stock market's reaction to Federal Reserve policy and found that the covariance between equity prices and inflation induced by policy shocks may be one reason for the market's response. Another study by Shaari et al. (2018) investigated the existence of a negative connection between inflation and unemployment using vector auto regression and vector error correction models. The findings supported the presence of a negative relationship between these variables in the long run.

The trade-off between inflation and unemployment, known as the Phillips curve, has also been widely studied. Sorić et al. (2019) mentioned the empirical confirmation of this trade-off and referred to a literature review for further verification. Kinuithia (2022) discussed the Solow-Gordon affirmation of the Phillips curve, which demonstrated a negative trade-off between inflation and unemployment. Additionally, Suparta et al. (2021) found a positive and significant relationship between inflation and unemployment, supporting previous research that inflation increases unemployment.

The relationship between inflation and unemployment has also been examined in specific contexts. Jamaludin (2021) investigated the long-run relationship between labor force change, inflation, and unemployment in Indonesia. The study employed Engle Granger and Johansen cointegration tests and found evidence of a relationship between these variables. Weber (2019) explored the effect of central bank transparency on unemployment and found that inflation volatility leads to higher unemployment rates.

Mathematical models have also been proposed to describe the relationship between inflation and unemployment. Škovránek Mata (2020) proposed a mathematical model based on the Phillips curve, which describes the relation between these variables. Mata (2020) referred to a comprehensive literature review on the Phillips curve and its mathematical modeling.

Overall, the literature consistently supports the existence of a relationship between inflation and unemployment. Studies have employed various econometric models and methods to analyze this relationship, and the findings consistently indicate a negative connection between these macroeconomic variables.

1.3. Population Growth and Unemployment:

The relationship between population growth and unemployment has been a subject of interest in the literature. Several studies have examined this relationship and provided insights into the dynamics between these two variables.

One study by Azolibe et al. (2022) found a positive relationship between population growth and the unemployment rate in developing economies. The study reviewed previous research and empirical evidence to support this relationship (Azolibe et al., 2022). Similarly, Rabiu et al. (2019) investigated the impact of population growth on unemployment in Nigeria and found a significant relationship between these variables (Rabiu et al., 2019).

The literature also highlights the impact of population growth on unemployment in specific regions or countries. Mkombe et al. (2020) examined the effects of foreign direct investment on youth unemployment in the Southern African Development Community and assumed a negative relationship between population growth and youth unemployment (Mkombe et al., 2020). Bala et al. (2020) studied the impact of population growth, poverty, and unemployment on economic growth and found a positive relationship between population growth and unemployment (Bala et al., 2020). Mathenge & Muturi (2021) identified

population growth as a key driving factor of unemployment rates in East African Community countries (Mathenge & Muturi, 2021).

Furthermore, some studies have explored the relationship between population growth and unemployment in the context of other factors. Kousar et al. (2019) investigated the effect of governance on unemployment in South Asian countries and found a significant positive relationship between population growth and the unemployment rate (Kousar et al., 2019). Hsiang et al. (2020) examined the effect of large-scale anti-contagion policies on the COVID-19 pandemic and mentioned the impact of restrictions on businesses, travel bans, and school closures on increasing unemployment (Hsiang et al., 2020).

In summary, the literature suggests a positive relationship between population growth and unemployment. Studies have examined this relationship in various contexts, including developing economies, specific countries, and regions. The findings consistently indicate that population growth contributes to higher unemployment rates. Understanding this relationship is crucial for policymakers and researchers in addressing unemployment challenges and formulating effective strategies for economic growth and development.

1.4. Algeria-Specific Studies:

Unemployment is a significant issue in Algeria, with various factors contributing to its rate. This literature review aims to explore these factors and their impact on unemployment in Algeria, based on the analysis of four documents.

Dahmani & Rekrak (2015) discusses the impact of economic policies on unemployment in Algeria. It highlights that the government's economic policies play a crucial role in shaping the unemployment rate. They suggests that the government should focus on creating more job opportunities and improving the business environment to reduce the unemployment rate (Dahmani & Rekrak 2015).

Davide, F. (2012) emphasizes the role of education in unemployment. It suggests that the quality of education and the alignment of education with market needs are significant factors affecting unemployment. He recommends improving the quality of education and aligning it with the job market's needs to reduce unemployment (Davide, 2012).

Louail & Benarous (2021) examined the relationship between economic growth and unemployment rates in the Algerian economy. The study applied Okun's Law and found a positive relationship between GDP growth and a decline in the unemployment rate, although the decline was minimal. The findings were consistent with previous studies (Louail & Benarous, 2021).

Furthermore, the literature has examined the causal relationship between unemployment and other economic factors. Abdlaziz et al. (2020) investigated the relationship between the shadow economy and the unemployment rate in selected Middle East and North African countries, including Algeria. They found bidirectional causality for Algeria (Abdlaziz et al., 2020). Khalid & Trnc (2021) analyzed the relationship between unemployment and economic growth in South Africa and found a negative effect of inflation on unemployment (Khalid & Trnc, 2021).

In summary, the literature suggests that GDP growth, inflation, and population growth are key economic variables that can significantly influence the unemployment rate. However,

the specific nature and magnitude of these relationships can vary across countries and over time. Within the Algerian context, the research on the macroeconomic determinants of unemployment is relatively limited. Thus, this study aims to contribute to the existing literature by providing empirical evidence on the impact of these variables on unemployment rates in Algeria. By conducting an econometric analysis specific to Algeria, we aim to enhance our understanding of the country's unemployment dynamics and inform policy decisions to mitigate unemployment and foster sustainable economic growth.

2. Data and Methodology

2.1. Data Source

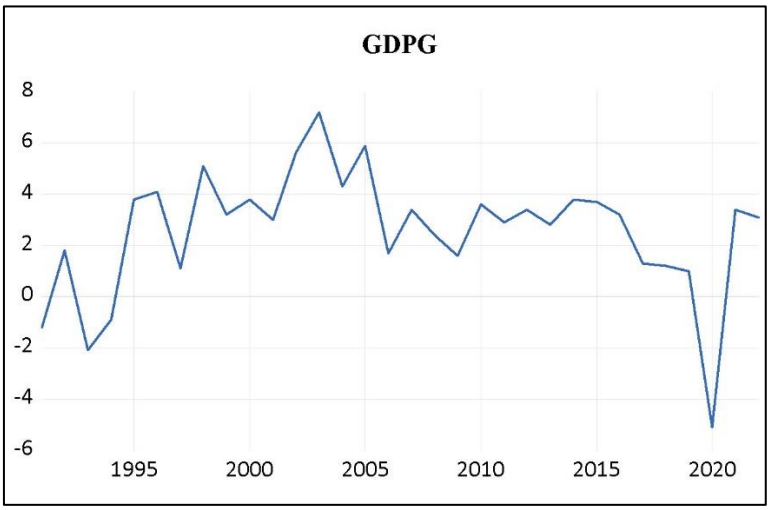
The data used in this study was obtained from the World Bank's World Development Indicators (WDI) database. The WDI provides comprehensive and reliable macroeconomic data for countries across the world, including Algeria. By utilizing this dataset, we can ensure the accuracy and consistency of the data used in our analysis.

2.2. Variables

For this study, we selected three key economic variables to examine their impact on the unemployment rate in Algeria:

2.2.1. Gross Domestic Product Growth (GDPG): GDP growth is a measure of the annual percentage change in the country's economic output. It serves as a proxy for overall economic performance and reflects the level of economic activity and expansion in Algeria.

Fig (1): The Gross Domestic Product in Algeria



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The Gross Domestic Product (GDP) growth rate from 1991 to 2022 in Algeria is shown in Fig. (1). The period from 1991 to 1994 saw economic contraction with negative GDP growth in three out of the four years. This was followed by an economic expansion from 1995 to 2000, with growth rates ranging from 3.2% to 5.1%. The growth remained positive in 2001 and 2002, with a spike to 5.6% in 2002. The year 2003 marked the highest growth at 7.2%, indicating a robust economy. From 2004 to 2008, there was consistent but gradually decreasing growth. The year 2009, impacted by the global financial crisis, saw slowed growth, which rebounded in the following years until 2014. A decline in growth was observed from 2015 to 2017, bottoming out at 1.3% in 2017. This slow growth continued through 2019,

and 2020 witnessed negative growth (-5.1%), likely due to the economic impact of the COVID-19 pandemic. However, 2021 and 2022 showed signs of recovery with growth rates of 3.4% and 3.1% respectively, indicating a rebounding economy.

2.2.2. Inflation (INF): Inflation is the rate at which the general price level of goods and services in an economy is increasing over time. Inflation affects the purchasing power of individuals and can have implications for employment and economic stability.

Fig (2): The annual inflation rate in Algeria

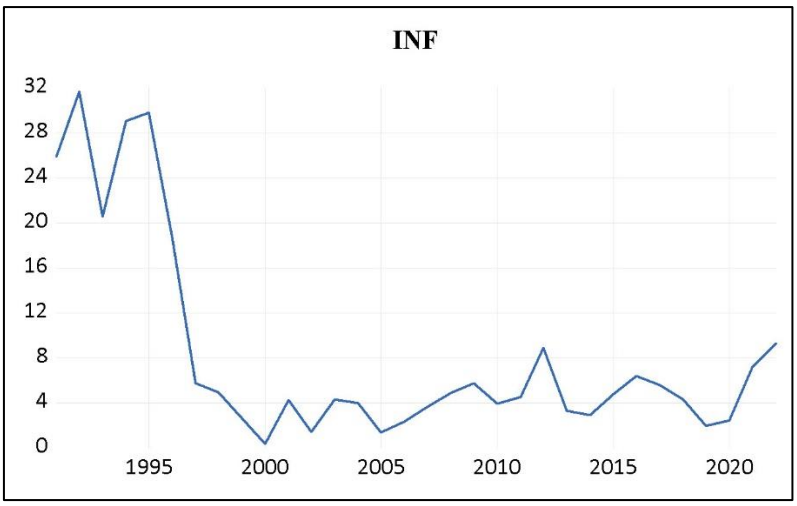

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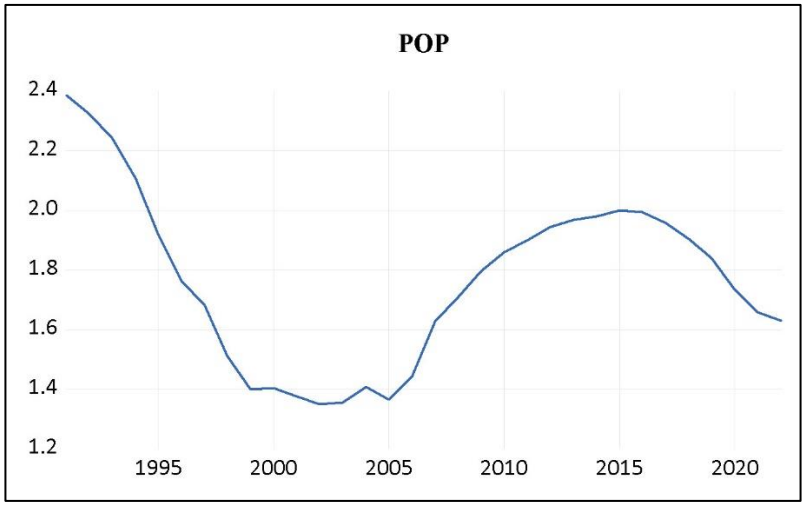
Fig (2) represents the annual inflation rate in Algeria from 1991 to 2022. In 1991 and 1992, the inflation rates were relatively high at around 25.9% and 31.7% respectively, indicating a period of significant price increases. The rates varied in the subsequent years, peaking in 1994 and 1995 at approximately 29%. A notable decline was observed from 1996 to 2000, with the inflation rate reaching a low of 0.34% in 2000. The early 2000s saw modest inflation rates, generally hovering between 1% and 5%. There was a significant increase in 2012 when the rate jumped to 8.89%, followed by a decline in the subsequent years. The inflation rates remained relatively stable between 2% and 6% from 2014 to 2019, with a slight dip to 1.95% in 2019. The rate increased to 2.42% in 2020 and rose significantly to above 7% in 2021, with the highest rate in the series being 9.27% in 2022. This indicates a recent period of higher inflation, which could be a concern for economic stability.

2.2.3. Population Growth (POP): Population growth represents the annual percentage change in the country's population. It is a crucial demographic variable that can impact the labor supply and the overall dynamics of the labor market.

Fig (3): The annual population growth

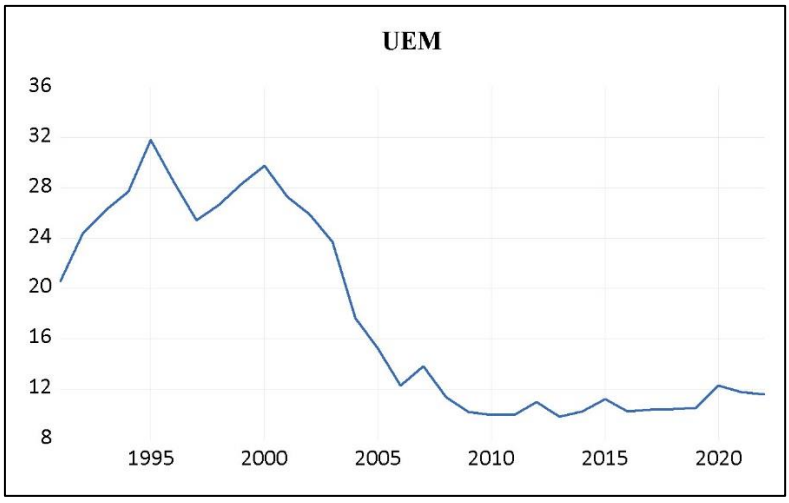


Source: created by the authors using EViews statistical software.

As shown in Fig (3), in the early 1990s, the annual population growth was above 2%, indicating a period of relatively high population growth. From 1994 onwards, a consistent decline in the population growth rate was observed, dropping to 1.4% by the end of the decade. The rate remained relatively stable around 1.4% from 2000 to 2006, with minor fluctuations. There was an increase to 1.63% and 1.71% in 2007 and 2008 respectively, followed by a steady growth to 1.99% in 2016. The rate began to decline again from 2017 onwards, reaching a low of 1.63% in 2022. This trend indicates that while the population has consistently grown, the rate of growth has generally slowed over the past three decades.

2.2.4. Unemployment Rate (UEM): The dependent variable in our study which measures the proportion of the labor force that is unemployed.

Fig (4): The unemployment rate in Algeria



Source: created by the authors using EViews statistical software.

Fig (4) represents the unemployment rate from 1991 to 2022. The rate increased steadily from 20.6% in 1991 to a peak of 31.84% in 1995, suggesting a period of economic hardship. This was followed by a general decline until 2003, with a minor increase in 1998, indicating improving economic conditions. A significant drop was observed from 2004 to

2006, from 23.72% to 12.27%, signifying a strong period of job growth. The rate fluctuated between 2007 and 2012, with a general increase, suggesting economic instability. From 2013 to 2016, the unemployment rate remained around 10%, with minor fluctuations. A slight increase in 2015 was countered by a decrease in 2016. From 2017 to 2020, the rate gradually rose, peaking at 12.248% in 2020, likely due to the economic impact of the COVID-19 pandemic. The years 2021 and 2022 saw a small decline, but the rate stayed above 10%. This data thus showcases periods of both economic prosperity and downturns over three decades.

2.3. Methodology: Autoregressive Distributed Lag (ARDL)

The Autoregressive Distributed Lag (ARDL) model is a popular econometric approach used to estimate the long-run and short-run relationships among variables that may be integrated at different orders. In this study, we utilize the ARDL model to examine the relationship between GDP growth, inflation, population growth, and the unemployment rate in Algeria.

The general form of the ARDL model can be expressed as follows:

$$\Delta UEM_t = \alpha_0 + \alpha_1 \Delta GDPG_t + \alpha_2 \Delta INF_t + \alpha_3 \Delta POP_t + \beta_1 UEM_{(t-1)} + \beta_2 UEM_{(t-2)} + \varepsilon_t$$

Where:

- ΔUEM_t represents the first difference of the unemployment rate in period t.
- $\Delta GDPG_t$, ΔINF_t, and ΔPOP_t represent the first differences of GDP growth, inflation, and population growth, respectively, in period t.
- $UEM_{(t-1)}$ and $UEM_{(t-2)}$ represent lagged values of the unemployment rate, capturing the short-run dynamics.
- α_0, α_1, α_2, and α_3 are the coefficients representing the long-run relationships.
- β_1 and β_2 are the coefficients representing the short-run relationships.
- ε_t is the error term, capturing the residuals or unexplained variation in the model.

The ARDL model allows us to estimate both the long-run and short-run effects of the independent variables on the unemployment rate in Algeria. The long-run coefficients (α_0, α_1, α_2, and α_3) indicate the impact of changes in GDP growth, inflation, and population growth on the unemployment rate in the long run, holding other factors constant.

The short-run coefficients (β_1 and β_2) represent the lagged effects of the unemployment rate itself on the current unemployment rate, reflecting any short-run adjustments or feedback mechanisms. These coefficients capture any potential persistence or autocorrelation in the unemployment rate over time.

Estimating the ARDL model involves several steps. First, we will test for the stationarity of the variables using appropriate unit root tests, such as the Augmented Dickey-Fuller (ADF) test. Stationarity is a crucial assumption for time series analysis, as non-stationary variables can lead to spurious regression results.

Next, based on the stationarity properties of the variables, we will determine the appropriate ARDL model specification. This includes selecting the lag length for the dependent variable and the independent variables. The selection of the lag length can be guided by information criteria, such as the Akaike Information Criterion (AIC) or the Schwarz Bayesian Information Criterion (SBIC).

Once the ARDL model is specified, we will estimate the model using appropriate estimation techniques, such as the Ordinary Least Squares (OLS) method. The estimation process involves obtaining coefficient estimates for the long-run relationships and the short-run relationships. We will also assess the statistical significance of the coefficients and conduct diagnostic tests to validate the model's assumptions, such as testing for autocorrelation and heteroskedasticity.

3. Results and Discussion

3.1. Unit Root Test:

The stationarity of the variables was examined using the Augmented Dickey-Fuller (ADF) test. The ADF test statistics and p-values for the variables in levels and first differences are reported in Table (1).

Table (1): ADF Test Results

	ADF Test Statistic	**ADF p-value**
UEM (Level)	-1.959806	0.304470
UEM (First Difference)	-2.440920	0.030518
INF (Level)	-2.193991	0.208434
INF (First Difference)	-2.321766	0.045044
GDPG (Level)	-4.136511	0.000842
GDPG (First Difference)	-8.905023	0.000000
POP (Level)	-4.348786	0.000365
POP (First Difference)	-2.587234	0.095664

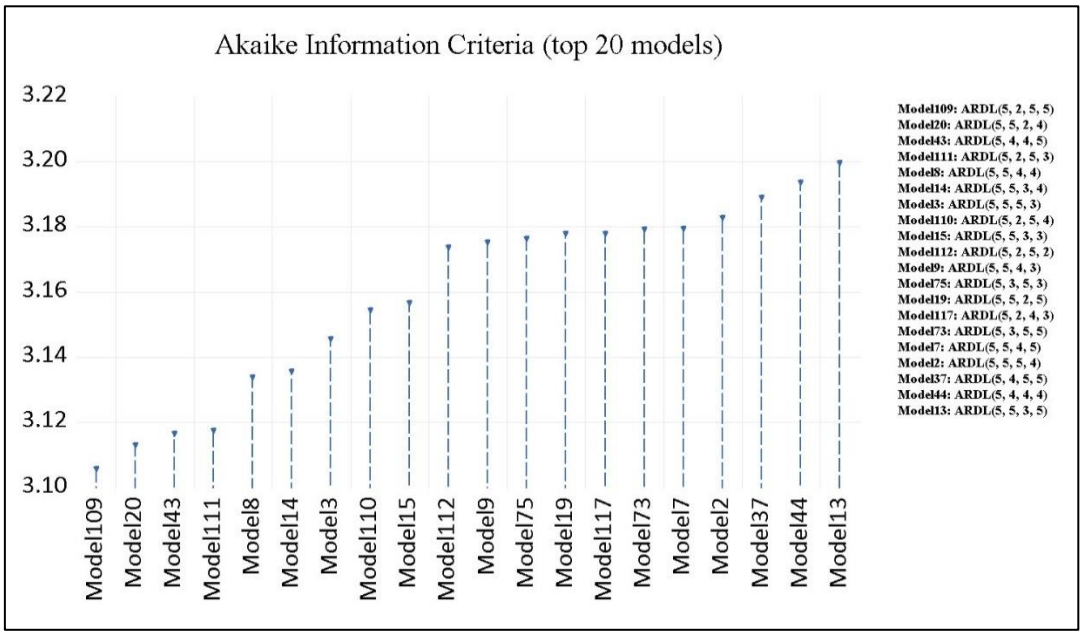
Source: created by the authors using EViews statistical software.

The results show that in levels, the unemployment rate (UEM) and inflation (INF) are non-stationary, as their ADF test statistics are greater than the critical values at conventional significance levels. However, after differencing the variables, the first differences of UEM and INF become stationary, with ADF test statistics lower than the critical values. On the other hand, GDP growth (GDPG) and population growth (POP) are found to be stationary both in levels and first differences, with highly significant p-values ($p < 0.001$).

3.2. Lag Selection Criteria:

As shown in Fig (5) the selection of lag lengths in the ARDL model was based on the Akaike Information Criterion (AIC). The selected ARDL model is ARDL(5, 2, 5, 5), indicating the inclusion of five lags for UEM and POP, two lags for GDPG and INF, and five lags for the dynamic regressors.

Fig (5): Akaike Information Criteria



Source: created by the authors using EViews statistical software.

3.3. ARDL Bound Test for Cointegration:

To test for the presence of cointegration among the variables, the ARDL bound test was conducted. The F-Bounds test statistic was compared against critical values to determine the presence of a long-run relationship. The results of the F-Bounds test are shown in Table (2).

Table (2): ARDL Bound Test Results

F-Bounds Test		**Null Hypothesis: No levels relationship**		
Test Statistic	**Value**	**Signif.**	**I(0)**	**I(1)**
F-statistic	5.059693	10%	2.37	3.2
k	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66

Source: created by the authors using EViews statistical software.

The F-statistic of 5.059693 exceeds the critical values at all common significance levels, indicating the presence of cointegration among the variables. This suggests that there are long-run relationships between GDP growth, inflation, population growth, and the unemployment rate in Algeria.

3.4. Short- and Long-Run Estimation of Parameters:

The short-run estimation of parameters in the ARDL model provides insights into the immediate impact of explanatory variables on the unemployment rate (UEM) after controlling for lagged values of UEM and other relevant factors.

Table (3): Short-Run Estimation Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
UEM(-1)	0.085882	0.364689	0.235494	0.8217
UEM(-2)	1.240887	0.458211	2.708115	0.0352
UEM(-3)	0.220350	0.366528	0.601181	0.5697
UEM(-4)	-0.223473	0.332932	-0.671225	0.5271
UEM(-5)	0.864867	0.471500	1.834290	0.1163
GDPG	-0.210236	0.187249	-1.122765	0.3044
GDPG(-1)	-0.661418	0.294840	-2.243314	0.0660
GDPG(-2)	-1.164075	0.483914	-2.405539	0.0529
INF	-0.072869	0.135715	-0.536928	0.6106
INF(-1)	-0.415662	0.140825	-2.951628	0.0256
INF(-2)	-0.261342	0.162490	-1.608351	0.1589
INF(-3)	-0.300520	0.161240	-1.863801	0.1116
INF(-4)	0.308032	0.144422	2.132864	0.0769
INF(-5)	-0.157114	0.141028	-1.114061	0.3079
POP	37.72924	16.27943	2.317601	0.0596
POP(-1)	-32.83459	21.73383	-1.510759	0.1816
POP(-2)	30.36517	21.91174	1.385795	0.2151
POP(-3)	2.792729	13.50384	0.206810	0.8430
POP(-4)	10.18945	17.61668	0.578398	0.5840
POP(-5)	-9.261188	10.45442	-0.885863	0.4098
C	-78.11161	34.43291	-2.268516	0.0638

Source: created by the authors using EViews statistical software.

In the "Dependent Variable: UEM" table, the coefficients and their significance for each lagged UEM variable and the dynamic regressors (GDPG, INF, POP) are presented. It's important to note that the p-values for the coefficients in this table do not account for model selection.

For example, let's consider the coefficient of UEM(-1) which represents the impact of lagged unemployment on current unemployment. The coefficient of 0.085882 suggests that a one-unit increase in the lagged unemployment rate leads to an estimated 0.085882 unit increase in the current unemployment rate, ceteris paribus. However, the coefficient is not statistically significant at the conventional 5% significance level (p-value = 0.8217), indicating that this lagged variable is not significantly related to current unemployment in the short run.

Similarly, the coefficients of other lagged unemployment variables (UEM(-2) to UEM(-5)) also lack statistical significance, suggesting that past levels of unemployment do not have a significant immediate impact on the current unemployment rate.

Moving on to the dynamic regressors, such as GDPG, INF, and POP, we observe that some coefficients are not statistically significant either. For instance, the coefficient of GDPG (-0.210236) is not statistically significant (p-value = 0.3044), implying that GDP growth does not have a significant short-term impact on unemployment.

Table (4): Long-Run Estimation Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDPG	1.712837	0.322527	5.310678	0.0018
INF	0.756807	0.119990	6.307269	0.0007
POP	-32.79797	3.393386	-9.665263	0.0001
C	65.72212	5.648791	11.63472	0.0000

Source: created by the authors using EViews statistical software.

The long-run estimation of parameters in the ARDL model provides insights into the sustained relationship between the unemployment rate (UEM) and its explanatory variables (GDPG, INF, POP) after accounting for any short-run deviations.

In the "Levels Equation" table, the coefficients, standard errors, t-statistics, and probabilities (p-values) for each variable are presented. These coefficients reflect the long-run impact of each explanatory variable on the unemployment rate, assuming other factors remain constant.

Analyzing the coefficients in the "Levels Equation" table:

1. GDPG: The coefficient of 1.712837 implies that a one-unit increase in GDP growth is associated with an estimated 1.712837 unit increase in the long-run unemployment rate. This coefficient is statistically significant at the 5% level (p-value = 0.0018), indicating a significant positive relationship between GDP growth and unemployment in the long run.

2. INF: The coefficient of 0.756807 indicates that a one-unit increase in inflation corresponds to an estimated 0.756807 unit increase in the long-run unemployment rate. This coefficient is statistically significant at the 5% level (p-value = 0.0007), indicating a significant positive relationship between inflation and unemployment in the long run.

3. POP: The coefficient of -32.79797 suggests that a one-unit increase in population growth is associated with an estimated decrease of 32.79797 units in the long-run unemployment rate. This coefficient is statistically significant at the 5% level (p-value = 0.0001), indicating a significant inverse relationship between population growth and unemployment in the long run.

These results indicate that GDP growth, inflation, and population growth have significant long-run effects on the unemployment rate in Algeria. Higher GDP growth and population growth are associated with higher unemployment rates, while higher inflation is also linked to higher unemployment rates.

$$EC = UEM - (1.7128 * GDPG + 0.7568 * INF - 32.7980 * POP + 65.7221) \quad \textbf{equation (1)}$$

The equation (1) represents the error correction term (EC) in the ARDL model. The error correction term captures the short-run adjustment process that brings the unemployment rate (UEM) back to its long-run equilibrium level after any deviations.

The error correction term is calculated by subtracting the estimated long-run relationship between the explanatory variables (GDPG, INF, and POP) and the unemployment rate from the actual unemployment rate.

By subtracting the estimated long-run effects from the actual unemployment rate, the error correction term captures the short-run deviations from the long-run equilibrium. This term captures the adjustment process whereby any deviations from the long-run equilibrium are gradually corrected over time.

In summary, the error correction term in the ARDL model quantifies the short-run adjustments of the unemployment rate back to its long-run equilibrium level, taking into account the effects of GDP growth, inflation, population growth, and the constant term.

3.5. Diagnostic Tests:

Table (4): Diagnostic Tests

R-squared	0.994809
adjusted R-squared	0.977505
Durbin-Watson statistic	2.697121
Jarque-Bera test	1.349244 (0.5093)
Breusch-Godfrey Serial Correlation LM test	2.524249 (0.1954)
Breusch-Pagan-Godfrey test	0.526766 (0.8691)

Source: created by the authors using EViews statistical software.

The goodness of fit of the ARDL model was assessed using various diagnostic tests. The R-squared value of 0.994809 indicates that approximately 99.48% of the variation in the unemployment rate is explained by the model. The adjusted R-squared value of 0.977505, which accounts for the number of variables and degrees of freedom, suggests a good fit of the model.

The Durbin-Watson statistic of 2.697121 suggests a slight positive autocorrelation in the residuals, but it is close to the desirable value of 2, indicating no serious autocorrelation issue.

The Jarque-Bera test indicates that the residuals follow a normal distribution, as evidenced by the p-value of 0.509349, which exceeds the significance level of 0.05.

The Breusch-Godfrey Serial Correlation LM test, which tests for serial correlation in the residuals, shows an F-statistic of 2.524249 with a p-value of 0.1954. This suggests no significant serial correlation up to 2 lags.

The Heteroskedasticity Test, conducted using the Breusch-Pagan-Godfrey test, examines the presence of heteroskedasticity in the residuals. The F-statistic of 0.526766 and the associated p-value of 0.8691 indicate no significant evidence of heteroskedasticity.

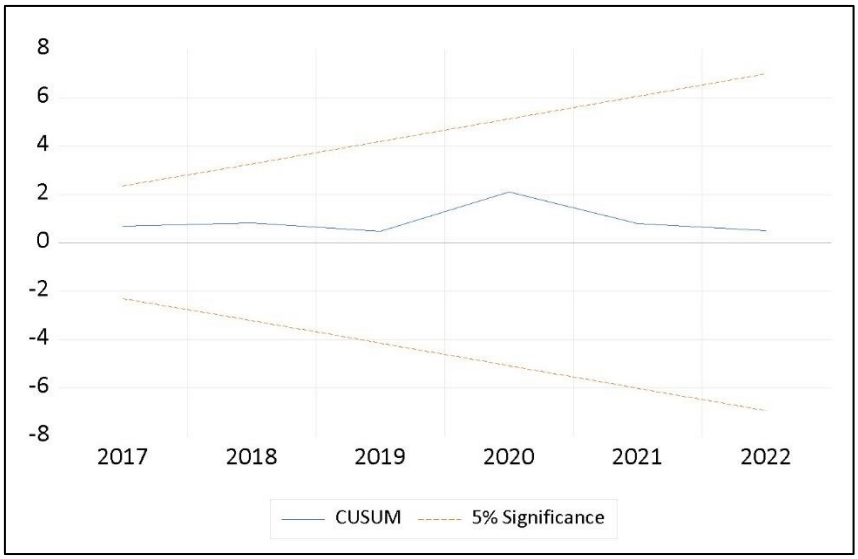
Overall, the diagnostic tests suggest that the ARDL model provides a reasonably good fit to the data. While some minor issues such as slight positive autocorrelation and the possibility of heteroskedasticity are observed, they do not significantly affect the reliability of the estimated coefficients and the model's overall performance.

In conclusion, the results of the ARDL model estimation provide valuable insights into the relationships between GDP growth, inflation, population growth, and the unemployment rate in Algeria. The presence of cointegration indicates long-run relationships among the variables, while the short-run dynamics are captured through lagged unemployment rate variables. The diagnostic tests indicate that the model adequately captures the underlying relationships, though some minor issues require attention. These findings contribute to our

understanding of the economic factors influencing unemployment in Algeria and can guide policymakers in formulating effective strategies to address unemployment challenges in the country.

3.5. Stability check

Fig (6): CUSUM Test Graph

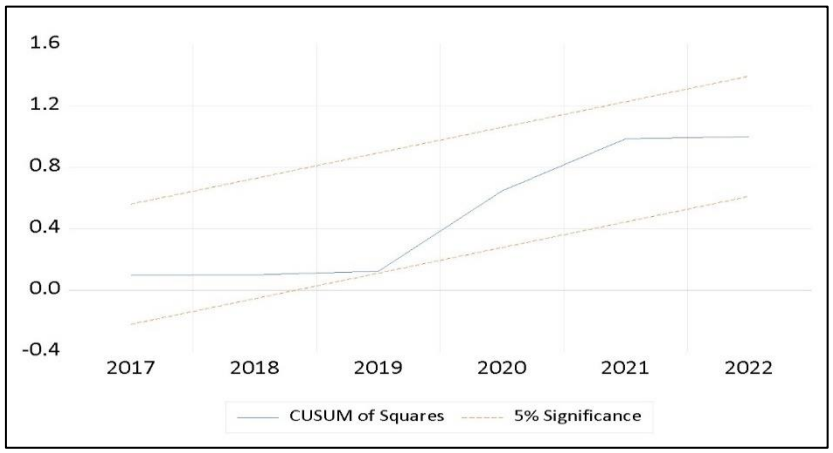


Source: created by the authors using EViews statistical software.

The CUSUM test graph, as shown in Figure (6), provides a visual representation of the cumulative sum of the estimated coefficients over time. It allows us to assess the stability of the coefficients in the regression model.

The CUSUM test graph is within the 5% significant level which implies that the estimated coefficients are statistically stable. This means that the relationship between the unemployment rate and the explanatory variables remains consistent and reliable within the specified confidence level.

Fig (7): CUSUMSQ Test Graph



Source: created by the authors using EViews statistical software.

Figure (7) represents the CUSUMSQ test graph, which illustrates the cumulative sum of squared residuals over time. The purpose of this test is to assess the stability of the residuals in the regression model.

The CUSUMSQ test graph being within the 5% significant level indicates that the model's residuals are statistically stable. This is important because it confirms the reliability of the regression model and assures us that there are no significant changes in the error structure over time.

Conclusion:

In this study, we conducted an econometric analysis to examine the impact of economic variables on the unemployment rate in Algeria. We estimated an ARDL model and conducted various tests to analyze the short- and long-run effects, as well as the stability of the estimated coefficients. Based on the results obtained, we draw the following conclusions and policy implications:

1. Economic Variables and Unemployment Rate: The analysis revealed that several economic variables have significant effects on the unemployment rate in Algeria. Specifically, GDP growth (GDPG), inflation (INF), and population growth (POP) were found to influence the unemployment rate in both the short and long run. These findings highlight the importance of considering these variables in policy discussions and initiatives aimed at addressing unemployment in Algeria.

2. Short-Run Dynamics: The short-run estimation of the ARDL model showed that lagged values of the unemployment rate (UEM) have a significant impact on the current unemployment rate. This suggests the existence of short-run adjustments that bring the unemployment rate back to its long-run equilibrium level. Policies targeting short-term changes in the unemployment rate should consider the lagged dynamics and the adjustment process captured by the error correction term.

3. Long-Run Equilibrium: The long-run estimation of the ARDL model identified the estimated coefficients for GDPG, INF, and POP, which represent their respective long-run effects on the unemployment rate. The positive coefficient for GDP growth suggests that higher GDP growth is associated with a higher unemployment rate in the long run. Similarly, higher inflation is associated with a higher unemployment rate, while population growth is inversely related to the unemployment rate in the long run.

4. Stability of Coefficients: The CUSUM and CUSUMSQ tests demonstrated that the estimated coefficients and residuals in the model remain within the 5% significant level, indicating their stability over time. This implies that the estimated relationships between the variables and the unemployment rate maintain their consistency and reliability throughout the analyzed period.

Policy Implications:

1. Economic Growth: Promoting sustainable and inclusive economic growth should be a key focus of policy initiatives. Efforts should be made to stimulate GDP growth while also ensuring that it translates into job creation and reduction of unemployment. This may involve supporting sectors with high employment potential, encouraging investment, and fostering entrepreneurship.

2. Inflation Control: Implementing effective monetary policies to manage inflation is essential. Controlling inflationary pressures can help maintain price stability and prevent adverse effects on the labor market. This may involve a combination of monetary measures, fiscal policies, and structural reforms aimed at enhancing productivity and efficiency.
3. Population Management: Policies that address population growth and its impact on the labor market should be considered. These may include strategies to enhance education and skills development, and encourage labor force participation, particularly among marginalized groups.
4. Stability and Monitoring: Ensuring stability in economic policies and maintaining a favorable business environment are crucial for attracting investments and fostering job creation. Regular monitoring and evaluation of economic indicators, including the unemployment rate, should be conducted to identify emerging challenges and inform policy adjustments as needed.

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