

How Do Oil Price Shocks Drive Unemployment Rates in Algeria: An Empirical Analysis Using the NARDL Approach 1980-2023

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ABSTRACT

This research paper aims to investigate the asymmetric effects of oil price shocks on unemployment rates in Algeria by employing the Nonlinear Autoregressive Distributed Lag (NARDL) model, using annual data spanning the period 1980–2023. The findings reveal the existence of a long-run cointegrating relationship. Symmetry tests indicate a significant asymmetric impact of oil prices on unemployment in Algeria, with unemployment responding more strongly and sensitively to negative oil price shocks than to positive ones in the long run. In the short run, negative oil price shocks have a significant and inverse effect on unemployment, whereas positive shocks show no significant impact. Gross Domestic Product (GDP) emerges as the most influential factor driving unemployment, displaying a significant inverse relationship in the long term. Meanwhile, inflation has no significant effect on unemployment rates in Algeria, either in the short or long run.

1. Introduction

The labor market represents the cornerstone of the economic structure of any country, playing a pivotal role in the allocation of human resources and the determination of income and wage levels. Employment and unemployment indicators emerge as key macroeconomic indicators that reflect the efficiency of economic performance and the extent of social welfare achieved. An efficient labor market serves as an engine of economic growth, a tool for poverty reduction, and a fundamental factor in promoting social stability.

Unemployment remains one of the most pressing challenges facing governments and policymakers due to its profound economic and social implications. Persistently high unemployment rates signal structural imbalances in the economy, leading to losses in productivity, wastage of human capital, worsening poverty, widening social disparities, and increased social unrest. Therefore, analyzing the mechanisms of labor market operations and understanding its dynamics is a fundamental prerequisite for designing successful economic policies.

In Algeria, providing stable and productive employment remains one of the most significant challenges for successive governments. Despite a decline in unemployment rates over the past two decades, the issue remains acute among youth and first-time job seekers, with unemployment rates in this group exceeding 20%. This situation carries

multiple social consequences, particularly given the rapid growth of the labor force in Algeria—faster than in other regions of the world—necessitating urgent and effective measures to address the phenomenon (Bouyacoub, 2012).

Historically, Algeria's employment policies were based on a centrally planned economic model, where the state acted as the primary employer and main source of job creation. Although this model helped stabilize unemployment rates for a time, it had adverse effects on labor productivity and efficiency. The 1986 oil price crash revealed the fragility of the Algerian economy, leading to rising unemployment and reduced investment as a result of economic stagnation. This coincided with demographic changes that further exacerbated the issue. In response, the government initiated economic reforms aimed at transitioning from a command economy to a market-based one. However, these transformations did not improve the labor market; rather, they intensified the problem, with unemployment rates doubling over the span of a decade and a half (Bouchaour & Al-Zeaud, 2012).

Data indicate that Algeria's overall unemployment rate stood at approximately 11.7% in 2023, down from 12.35% in 2022. According to global indicators, the annual rate for 2024 registered at about 11.43%. While this decline reflects gradual improvement, the rate remains higher than the pre-2013 average of 9.8%. Labor market sensitivity is especially pronounced among youth aged 15–24, with World Bank estimates indicating a youth unemployment rate of 29.76% in 2024, down from 30.45% in 2023. This rate has been gradually declining since the last quarter of the previous decade. In the same age group, other reports suggest an unemployment rate of around 30.8% in 2023. Meanwhile, the slow growth of formal and permanent job opportunities faces structural challenges, including the weak contribution of the private sector, expansion of the informal economy, and vulnerability to external shocks such as oil price fluctuations. In response, the government introduced unemployment support for individuals aged 19–40 to mitigate the effects of income loss.

Since the first oil shock in the 1970s, the relationship between oil price fluctuations and macroeconomic performance has garnered significant attention from economists. Hamilton demonstrated that rising oil prices had a negative impact on real GDP in the United States. Economic studies have confirmed that oil price shocks can influence unemployment in the short term, with effects that may also extend into the long term (Driouche & Hamrit, 2020).

Given that the labor market in Algeria and the unemployment rate are influenced more by economic variables than by demographic ones, analyzing the impact of global oil price shocks on unemployment in Algeria becomes particularly important. Such analysis can help inform the design of appropriate economic policies aimed at reducing high unemployment rates and stabilizing the labor market by creating new and sustainable job opportunities.

Research Problem:

What is the nature of the impact of oil price shocks on unemployment rates in Algeria?

Sub-questions:

- How do both positive and negative oil price shocks affect unemployment rates?
- What type of oil price shock has a statistically significant impact on the unemployment rate in Algeria?

Research Hypotheses:

- Oil price shocks have asymmetric effects on unemployment rates in Algeria.
- Declines in oil prices have a greater impact on unemployment rates than increases in oil prices.

Significance of the Study:

The importance of this study lies in its attempt to analyze the dynamic relationship between the variables under investigation by estimating a nonlinear model that helps reveal the asymmetric effects of oil price shocks on unemployment rates in Algeria.

Objectives of the Study:

This study focuses on analyzing the causal relationship between oil price shocks and fluctuations in unemployment rates in Algeria, aiming to understand the mechanisms through which global economic effects are transmitted to the domestic labor market.

Methodology:

This study employs the Nonlinear Autoregressive Distributed Lag (NARDL) approach to examine the asymmetric relationship between positive and negative oil price shocks and the unemployment rate in Algeria. The study also includes a causality test.

Structure of the Study:

Following the introduction in the first section, the second section provides a review of the relevant literature. The third section presents the data and study model. The fourth section covers the empirical analysis and discussion of results. Finally, the conclusion is presented in the fifth section.

2. Literature review

A study by (Driouche & Hamrit, 2020) investigates the effects of oil price shocks and selected macroeconomic variables on unemployment trends in Algeria during the period from 1990 to 2017, using the Nonlinear Autoregressive Distributed Lag (NARDL) model. In the long run, the results reveal the existence of cointegration among the variables, indicating long-term equilibrium relationships. Notably, negative oil price shocks were found to have a stronger impact on unemployment rates compared to positive shocks, confirming the asymmetric effect of oil shocks on unemployment in the long term. In the short run, the findings also demonstrate asymmetric effects of oil prices, consistent with the theoretical framework of many recent empirical studies, which suggest that negative shocks tend to exert a greater influence than positive ones. Diagnostic tests confirmed the absence of econometric issues in the estimated model. Furthermore, the results indicate that economic growth rates have a significantly greater effect on unemployment compared to investment spending and the volume of credit to the private sector. Additionally, the study found that non-hydrocarbon GDP does not accurately reflect the sector's contribution to reducing unemployment, as its growth was mainly attributed to previous booms in the hydrocarbon sector rather than sustainable expansion in non-oil activities.

As an oil-exporting country, Nigeria's economic growth and employment levels are significantly influenced by fluctuations in global oil prices. In this context, (Raifu et al, 2020) analyzed the impact of changes in real oil prices on the unemployment rate in Nigeria, applying both linear and nonlinear Autoregressive Distributed Lag (ARDL and NARDL) estimation techniques using quarterly data from 1979 to 2018. The findings from the linear ARDL model indicated that changes in oil prices have little to no significant effect on the unemployment rate. However, the results from the NARDL model revealed that both increases and decreases in oil prices have an insignificant positive effect on unemployment in the short run. In the long run, rising oil prices tend to worsen unemployment, while falling prices exert a negligible negative effect. Importantly, the study found evidence of a long-run asymmetric relationship between oil prices and unemployment. Based on these findings, the authors recommend that oil revenues should be strategically invested by the government to improve economic conditions and reduce unemployment.

(Cheratian et al, 2021) examined the impact of oil prices on unemployment rates in the Middle East and North Africa (MENA) region over the period 1991 to 2017, utilizing the Panel Nonlinear Autoregressive Distributed Lag (Panel NARDL) model. The results revealed that, in the long run, positive changes in oil prices were associated with an increase in unemployment rates. Conversely, negative oil price changes significantly contributed to reducing unemployment in the countries under study. In the short run, however, oil price fluctuations did not exhibit any notable effect on unemployment rates. The findings remained robust even when an alternative variable—oil revenue per country—was used, aligning with the resource curse theory. According to this theory, countries that heavily rely on natural resource revenues, such as oil and gas, tend to experience slower long-term economic growth and higher unemployment rates, on average, compared to countries that are less dependent on such resources.

The study titled "Oil Price Uncertainty and Unemployment in the United Kingdom: A Predictive Experience Using Random Forests over 150 Years" by (Gupta et al, 2022). investigates the relationship between oil price uncertainty and the unemployment rate in the UK using a nonlinear predictive model based on the Random Forests machine learning technique. The study utilizes a long historical dataset spanning from 1859 to 2020 and applies rolling estimation windows to assess the predictive power of oil price uncertainty in comparison with other economic and financial variables. For benchmark purposes, a Lasso regression model is also employed. The results demonstrate that oil price uncertainty possesses significant predictive power for changes in the unemployment rate, particularly over 6- to 12-month horizons. This predictive capacity was especially pronounced during the 1970s and 1980s. Moreover, the

findings reveal that uncertainty in oil prices is more informative than the actual changes in oil prices themselves in explaining unemployment fluctuations. The Random Forest model outperformed the Lasso model in terms of prediction accuracy, underscoring the value of nonlinear modeling approaches in economic forecasting. The study highlights that relying solely on linear models may be insufficient for capturing the complex dynamics of unemployment in the context of oil market volatility.

Another study by (Ahmed et al, 2023) explores the relationship between oil price uncertainty and the unemployment rate in the United States using an advanced econometric framework based on the Autoregressive Smooth Transition Logistic (ASTL) model. In this framework, oil price uncertainty is treated as a transition variable that determines the state of the economy—whether it is in a high- or low-uncertainty regime. The study utilizes monthly data covering the period from 1973 to November 2018, with the monthly unemployment rate as the dependent variable and oil price uncertainty as the transition variable. To assess the dynamic responses, the authors employ Generalized Impulse Response Functions (GIRFs). The results reveal that unemployment rises and becomes more persistent during periods of high oil price uncertainty, compared to periods of low uncertainty. Specifically, a shock to oil price uncertainty leads to a clear and sustained increase in unemployment under the high-uncertainty regime, while the same shock has no significant effect under low uncertainty. Furthermore, the response of unemployment is shown to be asymmetric, depending on the magnitude and direction of the shock, as well as the historical economic context. The findings highlight the importance of considering nonlinear and regime-dependent dynamics, and the authors emphasize that policymakers should avoid relying on simplistic linear estimates when designing labor market policies in response to oil market volatility.

A relatively recent study by (Shavvalpour et al, 2024) investigates the asymmetric interactions between oil price volatility, exchange rate fluctuations, and unemployment rates, particularly in major oil-exporting countries. The research focuses on a sample of oil-producing countries—Iran, Iraq, Kuwait, the United Arab Emirates, Saudi Arabia, and Nigeria—and uses annual data from 1990 to 2020. Employing the Nonlinear Autoregressive Distributed Lag (NARDL) methodology, the study aims to uncover asymmetric effects of oil price and exchange rate shocks on unemployment. The findings indicate that positive oil price shocks result in a significant increase in unemployment in the short run across the countries studied, whereas negative oil price shocks have no substantial short-term impact on unemployment. However, in the long run, positive oil price shocks exert a greater influence on unemployment than negative shocks. These results highlight the nonlinear and asymmetric nature of macroeconomic adjustments in oil-exporting economies, especially in response to external shocks related to the oil market and exchange rate movements.

The study titled “Oil Shocks and Unemployment Dynamics in Alaska: The Source of the Shock Matters” (Baek, 2024) examines the relationship between different types of oil shocks and the unemployment rate in the state of Alaska. The researchers employ a structural vector autoregression (SVAR) econometric model to analyze the effects of three categories of shocks: oil supply shocks, oil-specific demand shocks, and aggregate demand shocks. The analysis is based on time series data covering the Alaskan economy and investigates both short- and long-term effects, while also testing for asymmetries in the responses. The unemployment rate is used as the dependent variable, whereas the various types of oil and demand shocks serve as the independent variables. The findings indicate that both oil supply shocks and oil-specific demand shocks significantly affect unemployment in Alaska in both the short and long term. In contrast, aggregate demand shocks influence unemployment only in the short term. Furthermore, the results reveal asymmetric effects for oil-specific demand shocks in the long run, and for aggregate demand shocks in the short run, whereas oil supply shocks exhibit no significant asymmetric effects. The study underscores the importance of distinguishing between different sources of oil shocks when designing economic policies, particularly in energy-dependent economies like Alaska.

The recent study titled "The Relationship Between Crude Oil Prices, GDP, Inflation, and Unemployment: Evidence from Jordan" by (Khazaleh, 2024) investigates the impact of oil price fluctuations on key macroeconomic indicators in Jordan over the period 2000 to 2021, using quarterly data. The researchers employed the Autoregressive Distributed Lag (ARDL) model to analyze the relationship between oil prices as the independent variable and GDP, inflation, and unemployment as dependent variables. The findings revealed no statistically significant impact of oil prices on GDP or unemployment, whether in the short or long run. However, the study found a significant effect of oil prices on inflation in both the short and long term, based on the ARDL-ECM estimation. Accordingly, the study recommends that economic policymakers in Jordan take these results into consideration, particularly when designing import and energy-related policies, with the aim of mitigating the inflationary impact of oil price volatility, while noting that there is no immediate concern regarding its direct effects on economic growth or unemployment.

A relatively recent study by (Alfalih, 2024) examines the impact of key macroeconomic variables—namely oil prices, foreign direct investment (FDI) inflows, real GDP, and trade openness—on the unemployment rate in Saudi Arabia. The study employs the Autoregressive Distributed Lag (ARDL) model and the bounds testing approach to cointegration, using annual data spanning from 1991 to 2019. The results reveal that changes in all four variables have a significant negative effect on unemployment in the long run, suggesting that improvements in these indicators are associated with reductions in the unemployment rate. Notably, the study identifies a nonlinear relationship between oil prices and unemployment: the positive effect of rising oil prices on the labor market is only observed when the price per barrel exceeds \$41.2. Conversely, if oil prices fall below this threshold, labor market conditions deteriorate. Given that oil export revenues represent the primary source of income for Saudi Arabia, yet are subject to external factors and global price volatility, the study underscores the urgent need for economic diversification, particularly in growth-enhancing sectors, to foster job creation and reduce unemployment.

3. Data and Econometric technique

3.1 Data

The dataset used in this study comprises annual observations for the period 1980–2023. The variables are heterogeneous in nature and units: some are expressed as relative rates (e.g., unemployment rate and inflation rate), while others are measured in monetary terms, either in Algerian dinars or US dollars (e.g., GDP and oil prices).

To ensure robust econometric and statistical validity, the analysis is conducted using real values—i.e., all nominal variables are converted into constant prices to account for inflation. Furthermore, as is common in applied economic research, the study applies the natural logarithm transformation to the relevant variables. This approach offers several advantages, notably unit homogenization, variance stabilization, and the interpretation of estimated coefficients as elasticities.

Accordingly, the study model can be written as follows:

$$\text{LUNEMPL} = \mathcal{F}(\text{LRGDP}, \text{LROil}, \text{LInf})$$

The following table presents the study variables and their sources.

Table 1: Explanation of Variables and Data Sources.

Variable	Symbol	Definition and Measurement scales	Sources
Dependent variable	LUNEMPL	Annual Unemployment Rate (%).	World Bank
Independent variable	LRGDP	Real GDP Growth Rate (LRGDP): Measures the growth of real Gross Domestic Product at constant 2019 \$ US (using the GDP deflator).	World Bank
	LROIL	Annual Average of Real Oil Prices (Saharan Blend)	OPCE
	LINF	Inflation Rate (LINF): Measured by consumer prices (%)	National Office of Statistics (NOS)

Source: Prepared by the researchers based on statistical bulletins.

Note. **OPEC** : Organization of the Petroleum Exporting Countries

3.2 Econometric Technique

In order to study and analyze the nonlinear nature of the short- and long-term relationship between the dependent variable and the explanatory variables—while avoiding the issue of multicollinearity among the independent variables—we aim to estimate a model for the unemployment rate in Algeria as the dependent variable, with real GDP, real oil prices, and inflation rates as the independent variables. This will be done using the NARDL methodology, which reflects the asymmetric relationship between these variables.

Based on several studies, including those by (Driouche & Hamrit, 2020; Shavvalpour et al, 2024), applying this methodology requires decomposing the oil price variable into positive and negative shocks. Accordingly, the model can be specified as follows: $\text{Lunempl}_t = f(\text{LRGDP}_t, \text{troil}_t^+, \text{troil}_t^-, \text{Linf}_t)$

3.2.1 Model specification

We aim to estimate a model that captures the relationship between the unemployment rate as the dependent variable, and real GDP, positive and negative oil price shocks, and the inflation rate as independent variables. For this purpose, we employ the Nonlinear Autoregressive Distributed Lag (NARDL) methodology. After estimating the model, it is necessary to conduct a series of statistical and econometric diagnostic tests to assess the model's validity and its ability to explain the economic relationship among the variables.

According to (Shin et al, 2014) the model can be specified as follows:

$$Lunempl_t = f(Lrgdp_t, lroil_t^+, lroil_t^-, Linf_t, \varepsilon_t)$$

The above statement can be written as follows:

$$\begin{aligned} \Delta Lunempl_t = & c + \alpha_1 Lunempl_{t-1} + \alpha_2 Lrgdp_{t-1} + \alpha_3 Lroil_{t-1}^+ + \alpha_4 Lroil_{t-1}^- + \alpha_5 Linf_{t-1} \\ & + \sum_{i=1}^p \gamma_i \Delta Lunempl_{t-i} + \sum_{i=0}^{q_1} \varphi_i \Delta Lrgdp_{t-i} + \sum_{i=0}^{q_2} \omega_i^+ \Delta Lroil_{t-i}^+ + \sum_{i=0}^{q_3} \omega_i^- \Delta Lroil_{t-i}^- \\ & + \sum_{i=0}^{q_4} \eta_i \Delta Linf_{t-i} + \varepsilon_t \end{aligned}$$

On the other hand, the positive and negative shocks of oil prices are calculated as follows:

$$\begin{cases} Loil_t^+ = \sum_{j=1}^t \Delta Loil_j^+ = \sum_{j=1}^t \max(\Delta Loil_j, 0) \\ Loil_t^- = \sum_{j=1}^t \Delta Loil_j^- = \sum_{j=1}^t \min(\Delta Loil_j, 0) \end{cases}$$

Where:

- Δ : denotes the first differences;
- c : constant term;
- $\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5$: long-run parameters;
- $\gamma_i, \varphi_i, \omega_i^+, \omega_i^-, \eta_i$: short-run parameters;
- p, q_1, q_2, q_3, q_4 : optimal lag lengths for the variables: $Lunempl_t, Lrgdp_t, lroil_t^+, lroil_t^-, Linf_t$;
- ε_t : represents the error term;
- t : time trend.

3.2.2 Toda–Yamamoto causality

To determine the relationship between economic variables and subsequently formulate sound policies, we study the nature of the causal relationship between the variables of the study. For this purpose, we employ the long-run causality test developed by (Toda & Yamamoto 1995) -Long-Run Augmented Granger Causality Test-. This method relies on estimating a VAR(K + dmax) model following these steps:

- Identifying the order of integration (d) of the time series included in the model;
- Determining the optimal lag length (K) for the VAR model;
- Estimating the VAR(K + dmax) model, where dmax represents the maximum order of integration among the time series, according to the following formula:
-

$$\text{Lunempl}_t$$

$$= \alpha + \sum_{i=1}^k \gamma_i \text{Lunempl}_{t-i} + \sum_{i=k+1}^{k+d_{\max}} \gamma_i \text{Luempl}_{t-i} + \sum_{i=1}^k \theta_i \text{Lrgdp}_{t-i} + \sum_{i=k+1}^{k+d_{\max}} \theta_i \text{Lrgdp}_{t-i} + \sum_{i=1}^k \omega_i \text{Lroil}_{t-i} + \sum_{i=k+1}^{k+d_{\max}} \omega_i \text{Lroil}_{t-i} + \sum_{i=1}^k \eta_i \text{Linf}_{t-i} + \sum_{i=k+1}^{k+d_{\max}} \eta_i \text{Linf}_{t-i} + \varepsilon_t$$

The above equation highlights the causal relationship between the unemployment rate and the other explanatory variables.

4. Empirical findings and discussions

4.1 Stationary check

When analyzing time series and aiming to study cointegration, it is essential to test the stationarity of the variables and determine the order of cointegration. Stationarity testing is critically important as it helps to avoid the issue of spurious regression that may arise, and it also assists in identifying the appropriate model for econometric and empirical analysis.

There are several tests for stationarity found in the economic literature. Among them is the Dickey-Fuller (DF) unit root test, developed by (Dickey & Fuller, 1979), which is frequently used in time series analysis. Another well-known test is the Phillips-Perron (PP) unit root test, developed by (Phillips & Perron, 1988). It is widely recognized that the PP test is more robust than the DF test in the presence of autocorrelation and heteroskedasticity. As a result, the outcomes of the DF test are considered to be less reliable than those of the PP test (Kirca & Karagöl, 2019).

Regarding the methodology of both tests, the decision is made by comparing the absolute value of the computed test statistic with the critical values. The hypotheses are as follows:

- Null hypothesis (H_0): The series is non-stationary (has a unit root).
- Alternative hypothesis (H_1): The series is stationary (does not have a unit root).

If the absolute value of the test statistic is less than the critical value at conventional significance levels, then the null hypothesis H_0 is not rejected, meaning the series is non-stationary and contains a unit root. To make the series stationary, first differencing is applied. If the variable becomes stationary after first differencing, it is said to be integrated of order one, or $I(1)$.

Table 2: Stationary test.

Variables	PP			ADF			Decision
	III	II	I	III	II	I	
lunempl	-1.63	-1.10	-0.34	-3.50	-0.84	-0.35	I(1)
dlunempl	-5.29***	-5.22***	-5.28***	-5.28***	-5.21***	-5.27***	
lroil	-2.42	-0.99	0.35	-2.46	-1.05	0.48	I(1)
dlroil	-6.24***	-6.23***	-6.27***	-5.79***	-5.73***	-5.75***	
lrgdp	-0.42	-1.71	5.40	-1.84	-0.38	7.21	I(1)
dlrgdp	-4.25***	-4.31***	-2.37**	-4.26***	-4.32***	-2.58**	
linf	-3.00	-2.81	-1.01	-2.94	-2.80	-1.21	I(1)

dlnf	-8.88***	-8.92***	-9.03***	-8.84***	-8.88***	-8.99***	
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Source: Authors' calculation.

Note: *, **, and *** denote significance levels at 10%, 5%, and 1%, respectively. d(..): indicates first difference.

I : Model without constant or trend. II : Model with constant only. III: Model with both constant and trend

After examining the stationarity of the time series for the variables, we found that all variables are stationary at the first difference. Therefore, it is possible to apply the NARDL model, as the first condition is fulfilled namely, that all variables are integrated of order one, I(1). In addition, the sample size of the study consists of 44 annual observations (more than 30 observations), which confirms the fulfillment of the second condition.

4.2 Detection of Multicollinearity Among the Independent Variables

Before estimating the required econometric models, it is essential to begin with a crucial step involving the calculation of the correlation coefficients between the independent variables or the computation of the Variance Inflation Factor (VIF).

This is done to avoid econometric issues such as multicollinearity among the independent variables, which could lead to spurious model estimations that do not accurately reflect the true relationship between the study's variables (Shrestha, 2020).

To check for the presence or absence of multicollinearity among the independent variables, the Variance Inflation Factor (VIF) will be analyzed. As a general rule, if the VIF value exceeds 10 ($VIF > 10$), this indicates the presence of a multicollinearity problem among the explanatory variables (Kutner, 2005, p 409).

Table 3: Variance Inflation Factor (VIF) Values.

Independent variable Dependent variable	LRGDP	LOIL	LINF
LRGDP	--	1.11	1.11
LINF	2.60	2.60	--
LOIL	1.21	--	1.21

Source: Authors' calculation.

Based on the table above, it can be observed that there is no problem of multicollinearity among GDP, inflation rate, and oil prices, as the calculated VIF values for these variables are less than 10. Therefore, these three variables can be combined as independent variables in a single model. Consequently, it is possible to construct econometric models in which the issue of multicollinearity among the independent variables does not exist.

4.3 NARDL bounds test

This test helps determine whether there is a long-run equilibrium relationship between the dependent variable and the other independent variables included in the model, and this is done by relying on the F-statistic (Hussein & Hmood, 2024; Cañal & Fernández, 2018).

The steps of the Bounds Test involve estimating the NARDL model and formulating the long-run relationship equation, then conducting an F-test for the null hypothesis which states that there is no long-run equilibrium relationship (i.e., no cointegration), against the alternative hypothesis that there is a long-run equilibrium relationship (i.e., cointegration exists). When interpreting the F-test results, the calculated F-statistic is compared with the critical values from the Bounds table: if the calculated F-value exceeds the upper bound, the null hypothesis is rejected, confirming the existence of a long-run relationship; if it falls below the lower bound, we fail to reject the null hypothesis, indicating no long-run relationship; and if the F-value lies between the lower and upper bounds, the result is inconclusive.

Table 4: F-Bounds Test Results - NARDL model.

Statistical Test	Value	Significance Level	Lower Bound I(0)	Upper Bound I(1)	Result
Calculated F-statistic	4.33	10%	2.20	3.09	a long-run equilibrium relationship exists at a significance level above 2.5%.
		5%	2.56	3.49	
		2.5%	2.88	3.87	
		1%	3.29	4.37	

Source: Authors' calculation.

We observe from the table above that the F-statistic value for the Bounds test is 4.33, which clearly exceeds the upper bound critical values I(1) at all significance levels (2.5%, 5%, and 10%). Accordingly, the null hypothesis stating that there is no long-run relationship between the variables is rejected. Therefore, this test confirms the existence of a long-run cointegration relationship between the unemployment rate and the other explanatory variables.

4.4 Estimation of the Long and Short Run Relationships, and Diagnostic Tests

Table 5: Long-run Estimates (Dependent Variable: LUNEMPL).

Variables	Coefficients	T -Statistic	Probability (p-value)
LRGDP	-1.86	-2.25	0.03
LROIL+	-0.30	-1.64	0.108
LROIL−	-0.78	-6.83	0.000
LINF	-0.03	-0.77	0.44
C	58.27	2.35	0.02

Source: Authors' calculation

The above table clearly shows that both LROIL− and LRGDP have a statistically significant long-run impact on unemployment rates in Algeria. On the other hand, LROIL+ and LINF are statistically insignificant, meaning they do not exhibit a clear influence on unemployment in the long term. In other words, LROIL+ and LINF do not show a meaningful effect on unemployment over the long run. Additionally, both LROIL− and LROIL+ have a negative (inverse) effect, as do LRGDP and LINF, indicating an inverse relationship with the unemployment rate.

After identifying the long-run relationship, we proceed to estimate the Error Correction Model (ECM), which captures the short-run dynamics between the explanatory variables and the dependent variable, according to the following specification:

$$\Delta L_{unempl}_t = c + \sum_{i=1}^p \gamma_i \Delta L_{unempl}_{t-i} + \sum_{i=0}^{q_1} \varphi_i \Delta L_{rgdp}_{t-i} + \sum_{i=0}^{q_2} \omega_i^+ \Delta L_{roil^+}_{t-i} + \sum_{i=0}^{q_3} \omega_i^- \Delta L_{roil^-}_{t-i} + \sum_{i=0}^{q_4} \eta_i \Delta L_{inf}_{t-i} + \psi ECT_{t-1} + \varepsilon_t$$

Table 6: Short-run Estimates (Dependent Variable: $\Delta LUNEMPL$).

Variables	Coefficients	T -Statistic	Probability (p-value)
$\Delta LROIL-$	-0.140	-2.002	0.053
Coint Eq (-1)	-0.394	-5.45	0.000

Source: Authors' calculation

From the above table, we observe that the coefficient of the error correction term (ECT = -0.394) is statistically significant and carries a negative sign, which is economically acceptable. This indicates that 39.4% of the disequilibrium is corrected in the long run, supporting the existence of a long-term equilibrium relationship among the variables. Moreover, the value of -0.394 reflects the speed of adjustment, meaning that 39.4% of the deviation from equilibrium in the unemployment rate from period (t-1) is corrected in the current period (t).

Table 7: Long and Short run Asymmetry Test

Long run Asymmetry Test			
Variable	Coefficients	F-Statistic	Probability (p-value)
LROIL	-0.030	5.24	0.028
Short run Asymmetry Test			
Variable	Coefficients	F-Statistic	Probability (p-value)
LROIL	-0.21	2.26	0.14

Source: Authors' calculation

Based on the Wald symmetry test shown in Table 7 for both the long term (WL) and short term (WS), we can state that for the oil price variable, there is an asymmetric (nonlinear) relationship in the long run. This is evidenced by the WL test statistic, which is 5.24 and statistically significant at the 5% level (p-value = 0.02). Therefore, we reject the null hypothesis ($H_0: \alpha_3 = \alpha_4$) and accept the alternative hypothesis, which suggests the presence of asymmetry. In other words, positive and negative shocks in oil prices have an asymmetric effect on unemployment in the long run.

In the short run, however, the WS test statistic is 2.26 with a relatively large p-value of 0.14, which is greater than common significance levels. Thus, we fail to reject the null hypothesis ($H_0: \sum_{i=0}^{q_2} \omega_i^+ = \sum_{i=0}^{q_3} \omega_i^-$), indicating that the relationship between the variables is symmetric (linear) in the short run. In other words, positive and negative oil price shocks have a symmetric effect on unemployment in the short run.

Table 8: Diagnostic Tests

Test	F-Statistic	p-value
LM (Autocorrelation)	0.48	0.62
ARCH (Heteroskedasticity)	0.10	0.75
JB (Normality of Residuals)	2.2	0.33
RESET (Functional Form)	7.11	0.011
CUSUM	—	Stable
CUSUMQ	—	Stable

Source: Authors' calculation

after estimating the error correction model using the NARDL approach, it is essential that the model is free from various econometric issues. For this purpose, a set of diagnostic tests was conducted as shown in Table 8.

The Lagrange Multiplier (LM) test for autocorrelation of residuals indicates a p-value of 0.62, which is not statistically significant at the 10% level, suggesting the absence of serial correlation in the model residuals at the 10% level. Moreover, the ARCH test confirms homoskedasticity, as the test statistic is 0.10 with a p-value of 0.75, which is greater than the conventional significance levels, indicating constant variance of the residuals. As for the Jarque-Bera (JB) test for normality of residuals, the test statistic is 2.2 with a p-value of 0.33, which exceeds the 10% significance level, leading to the acceptance of the null hypothesis that the residuals are normally distributed. Regarding the Ramsey RESET test for model specification, the p-value is 0.011, which implies the model is correctly specified, especially since the value exceeds the 1% significance level. Additionally, the CUSUM and CUSUMQ tests, as illustrated in Appendix 1, indicate stability and good consistency of the model over time.

4.5 Discussion

after conducting the diagnostic tests, all of which yielded acceptable results, we now proceed to the analysis of the econometric results and their economic interpretation, in order to understand the mutual impact between the unemployment rate in Algeria and the independent variables, namely: real GDP, positive and negative oil price shocks, and the inflation rate.

4.5.1 Short-Run Results Analysis.

- The value of the error correction term (-0.394) is statistically significant at the 1% level and carries a negative sign, which confirms the validity of the long-run equilibrium relationship and the existence of an error correction mechanism in the model. This parameter reflects the speed at which the model adjusts from short-run imbalances toward long-run equilibrium. Specifically, the value ECM = -0.394 in the first model indicates that the unemployment rate adjusts toward its equilibrium value at a rate of 39.4% per year. In other words, when the unemployment rate deviates from its long-run equilibrium in period (t-1), 39.4% of this deviation is corrected in the current period (t). It can also be said that the unemployment rate takes approximately two years and six months (≈ 2.53 years, calculated as $1 / 0.394$) to fully return to its equilibrium value following a shock in the model caused by changes in the explanatory variables.
- The short-run elasticities show a significant and negative effect of negative oil price shocks on the unemployment rate. A negative shock in oil prices (i.e., a decrease in oil prices) leads to an increase in the unemployment rate by 0.14 units, a result consistent with economic theory.
- There is no significant short-run effect of real GDP, inflation rate, or positive oil price shocks on the unemployment rate in Algeria.

4.5.2 Long-Run Results Analysis

The long-run relationship can be written as follows:

$$Lunempl_t = -1.86 * Lrgdp_t - 0.30 * Lroil_t^+ - 0.78 * Lroil_t^- - 0.03 * Linf_t + 58.27$$

- There is a significant and inverse (negative) effect of real GDP on unemployment rates in Algeria. An increase in real GDP by one unit leads to a decrease in the unemployment rate by 1.86 units.
- There is an insignificant but negative effect of positive oil price shocks on unemployment. When a positive oil price shock occurs (i.e., an increase in oil prices), the unemployment rate decreases by 0.30 units.
- On the other hand, negative oil price shocks have a significant and negative impact on unemployment. That is, when a negative oil price shock occurs (i.e., a decrease in oil prices), the unemployment rate increases by 0.78 units.
- The results of the symmetry tests indicate that there is an asymmetric relationship between oil prices and unemployment in Algeria, where unemployment is more responsive and sensitive to negative oil price shocks than to positive ones.
- Inflation shows a negative but statistically insignificant effect on unemployment. An increase in the inflation rate by one unit leads to a decrease in unemployment by only 0.03 units, which is a very weak effect.

4.6 Verification of Toda-Yamamoto Causality

Based on the previous results, all time series are stationary at the first difference, i.e., $I(1)$, and thus $dmax = 1$. We now proceed to determine the optimal lag length for the VAR model, relying on several criteria, most notably the Akaike Information Criterion (AIC) and the Schwarz Criterion (SC). The results are presented in the following table:

Table 9: Optimal lag length

Criteria \ Lag	P=0	P=1
AIC	3.51	-3.96
SC	3.86	-3.12

Source: Authors' calculation

Based on the table above, we find that $p = 1$, which corresponds to the lowest values of both the Akaike Information Criterion (AIC) and the Schwarz Criterion (SC). Accordingly, we estimate the model $VAR(k + dmax) = VAR(1 + 1) = VAR(2)$ for the independent variables, in order to perform the Toda-Yamamoto long-run causality test. The results of the test are presented in the following table:

Table 10: Toda-Yamamoto causality test

Dependent Variable: LUNEMPL			
Independent Variables	Chi-square Statistic (χ^2)	Degrees of Freedom	p-value
LINF	0.03	1	0.86
LRGDP	0.14	1	0.69
LROIL	3.47	1	0.06

Source: Authors' calculation

Based on the results presented in the table above, we can conclude the following:

- We accept the null hypothesis: LINF does not Granger-cause LUNEMPL, since the p-value (0.86) is greater than the significance levels of 1%, 5%, and 10%;
- We accept the null hypothesis: LRGDP does not Granger-cause LUNEMPL, since the p-value (0.69) is greater than the significance levels of 1%, 5%, and 10%;
- We reject the null hypothesis: LROIL does Granger-cause LUNEMPL, since the p-value (0.06) is less than the 10% significance level.

From the above, we conclude that oil prices are the most significant determinant of the unemployment rate in Algeria in the long run, as they contribute to both increases and decreases in employment levels.

5. Conclusion

Oil price shocks play a significant role in shaping the Algerian economy, particularly due to the country's strong dependence on oil revenues as its principal source of national income. Over the years, changes in oil prices have had a noticeable impact on the labor market, with unemployment rates responding both directly and indirectly to these fluctuations.

When oil prices are high, Algeria experiences increased fiscal revenues, enabling the government to boost public investment across multiple sectors. This, in turn, fosters job creation and helps reduce unemployment levels.

On the other hand, falling oil prices often lead to cutbacks in public expenditure, slower economic growth, and a rise in unemployment particularly in light of the country's limited economic diversification. Such episodes have underscored the urgent need for more sustainable economic policies that lessen reliance on oil revenues and promote investment in alternative, productive industries.

Accordingly, the formulation of comprehensive and adaptable development strategies is essential for reducing the adverse effects of oil price shocks on unemployment in Algeria. These strategies would play a key role in stabilizing the labor market and advancing long-term, sustainable economic growth.

Based on the above, we attempted to examine the impact of oil price shocks on unemployment rates in Algeria by relying on previous studies and relevant economic theories, covering the period from 1980 to 2023. The results of the applied study were found to be, to some extent, consistent with economic theory.

The findings of the stationarity test revealed that all variables, taken in real terms and logarithmic form, were stationary or integrated of the first order. Based on this result, econometric models were estimated to reflect the nature of the relationship between the dependent variable and the independent variables, using the NARDL (Nonlinear Autoregressive Distributed Lag) methodology. This modeling was accompanied by several diagnostic and statistical tests to ensure the robustness and validity of the empirical results, which were as follows:

- The results of the NARDL methodology revealed the existence of a cointegrated relationship among the variables under study, indicating a long-run equilibrium association between them. It was found that real GDP has a significant and negative impact on the unemployment rate, whereby a one-unit increase in real output leads to a 1.86-unit decrease in unemployment—consistent with economic theory.
- Regarding oil price shocks, the findings indicate an asymmetric relationship between positive and negative shocks and the labor market. Positive oil price shocks (price increases) have a negative but statistically insignificant impact on unemployment, with a 0.30-unit reduction in the unemployment rate. In contrast, negative oil price shocks (price decreases) have a significant and adverse impact, leading to a 0.78-unit rise in the unemployment rate. The results of the symmetry tests confirm this discrepancy, showing that unemployment is more sensitive to negative oil price shocks than to positive ones, reflecting the vulnerability of the labor market to oil price volatility.
- Algeria's heavy reliance on the hydrocarbons sector as a primary revenue source makes the national economy highly susceptible to oil price cycles. During periods of high oil prices, the country experiences economic recovery, increased revenues, and higher public spending, which boost investment and job creation, thereby reducing unemployment. Conversely, falling oil prices lead to economic contraction, reduced public spending, job cuts—especially in the public sector—and increased participation in the informal labor market, resulting in higher unemployment rates.
- On the other hand, the analysis showed a negative but statistically insignificant impact of inflation on unemployment. This weak relationship is understandable in the Algerian context, particularly following the 2019 COVID-19 pandemic, which brought a significant rise in inflation due to imported inflation and expansionary monetary policies such as money printing. This was accompanied by higher unemployment rates resulting from business closures, workforce downsizing, and government austerity in hiring due to the global economic and health crisis.
- Finally, the results of the causality test using the Toda-Yamamoto approach confirmed that oil prices are among the key determinants of unemployment in Algeria, in addition to real GDP, which plays a significant role in the long run.

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7. Appendix List

Appendix No. 1: Cumulative sum of recursive residuals and cumulative sum of squares of recursive

