



THE EFFECTS OF OIL PRICE SHOCKS ON THE INDUSTRIAL SECTOR IN ALGERIA (1999:Q1-2022:Q1)

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Abstract: This paper investigates the symmetric and asymmetric effects of real oil price shocks on industrial output in Algeria over the period 1999:Q1–2022:Q1. We use a linear autoregressive distributed lag model (ARDL), and nonlinear autoregressive distributed lag model (NARDL). The ARDL model reveals that the results seems to have been misspecified and the estimates are unstable. However, the NARDL model shows that only a real oil price increase seems to rise industrial output in the short-term. In the long-term, oil price increase (decrease) raised (reduced) the industrial output. Furthermore, we found that bank credit and inflation have a positive and negative effect on industrial output, respectively. The coefficients of discount rate and exchange rate are insignificant and reflect the ineffective of monetary policy and successive devaluation of the Dinar in improving the competitiveness of industrial sector in Algeria.

Key words: Industrial output, oil price shocks, Algeria; Asymmetry, NARDL model.

Jel Classification Codes: L6, Q43.

Introduction:

Understanding the effects of oil price shocks on macro economy has been an issue of concern to both policymakers and researchers in oil-importing and exporting countries in recent decades. From a theoretical point of view, oil price shocks influence economic activity through six channels: supply-side shock effect, wealth-transfer effect, inflation effect, sector-adjustment effect, and uncertainty effect (Brown and Yücel, 2002; Cologni and Manera, 2008).

Due to the importance of industrial sector as a leader sector to diversify the economy and improve the competitiveness of exports, numerous empirical studies have examined the impact of oil price shocks on industrial output in oil-importing and exporting countries (see section 2). These effects in oil importing countries differ from those of oil exporting countries. In this regard, an increase in oil prices rise the production costs, and leads to a contraction in investment and industrial production in oil-importing countries (Kumar, 2009; Wang and Zhang, 2014). In oil-exporting countries, a boom in oil prices affect positively the industrial production by improving hydrocarbon revenues that finance government expenditures (Bjornland, 2008). Other researchers showed that increased oil price could reduce industrial production in oil-exporting countries by reducing trade through higher prices of imported inputs of industry from oil-importing countries (Farzanegan and Markwardt, 2008).

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Since the independence, Algerian authorities have implemented different industrial strategies to meet the challenges of development, and to benefit from the industrial capacities of the country. During the socialist orientation, government has adopted import substitution strategy based on heavy industry called **industrializing industries' model**. Under the impact of the oil price shocks of 1986 and the debt crisis, the government undergone significant economic reforms since 1990, and began the transition process to market-based economy. During this period, the reform under the stabilization and Structural Adjustment Programs have affected negatively the industrial sector, because it has aggravated deindustrialization and closed several public industrial enterprises. Since 2000, due to the rise of oil and gas revenues, there was a renewed interest in industrial policy to achieve economic diversification. Despite the large investment program in industry, the production structure was distorted in favor of hydrocarbon and at the expense of the industry.

However, the failure of the Algerian manufacturing strategy increased the vulnerability of the industrial production and the performance of the economy to oil price shocks. In fact, the industrial sector in Algeria did not benefit from prolonged higher oil prices as confirmed by several indicators: the decline in the industrial production to GDP ratio, the small share of industrial exports in total exports, and the weak contribution of industries with higher value added in the industrial sector (see section 3). For these reasons, the long-term weak oil price will affect negatively the industrial production. This resides in the fact that low oil prices will reduce government revenues and increase the budget deficit significantly. To face this situation, the government will adopt a restrictive fiscal policy that decrease the demand and affect negatively the non-hydrocarbon sectors, such as industry.

In this paper, we estimate the determinants of industrial production in Algeria during 1999:Q1-2022:Q1. We then test whether the real industrial production exhibits symmetric or asymmetric responses to real oil price shocks. Algeria represents an interesting case for several reasons. First, to the author's knowledge, this is the first study that estimated the symmetric and asymmetric effects of oil price shocks on industrial production in Algeria. Second, given the importance of oil prices in macroeconomic performance, this study investigates the impact of oil price shocks and other determinates on industrial sector in Algeria by including the macroeconomic fundamentals. The findings of this study will lead to an understanding of how industrial policy can be effectively employed to solve problems in the ailing manufacturing sector in Algeria, as leader sector to diversify the economy.

Third, the empirical studies of the impact of oil price shocks on industrial production used linear co-integration methods. Our estimation is novel, because it explores the asymmetric effects of oil price shocks on industrial sector in the short-term and long-term, by employing a nonlinear ARDL model as developed by Shin et al. (2014).

The paper is structured as below: In section 1, we present a review of literature. Section 2 presents the state of industrial sector in Algeria. Section 3 discuss data and econometric methodology. Section 4 sets forth our main results. Finally, conclusion concludes the paper.

1. Literature Review

The impact of oil price shocks on industrial sector have been the object of several studies in both oil importing and oil exporting countries. For the importing countries, Lee and Ni (2002) employed the Vector Autoregressive Model (VAR) to investigate the effects of oil price shocks on different industries in the US economy. The findings suggest that oil price shocks reduced supply in the industries that are oil-intensive in the production (petroleum refinery and industrial chemicals). In contrast, for other industries, such as automobile industry, oil price shocks reduced the demand. In another paper, Kliesen (2006) found that oil price increase affect negatively wood and furniture, and fabricated metal industries in the United States of America.

Alper and Torul (2009) investigated the asymmetric effects of oil price on manufacturing sector in Turkey. The results showed that oil price increase robustly impede several

manufacturing sub-sectors, including wood and wood products, furniture, chemicals and chemical products, and rubber and plastic products, electrical machinery, and radio, TV and communication apparatus.

Jiménez-Rodríguez and Sanchez (2012) employed the VAR model and found that oil price increase affected negatively industrial production, and positively inflation in Japan. Wang and Zhang (2014) studied the asymmetric effects of oil shocks on grains, metals, petrochemicals, and oil fats in China. The results suggest that the four subsectors negatively affected by oil price increase, and the asymmetric effects exist.

Aye et al. (2014) examined the symmetric and asymmetric effects of oil price shocks on industrial production in South Africa. The findings revealed that increased oil prices affected negatively the industrial production, and the asymmetric effects exist.

In the case of oil exporting countries, Mehrara and Sarem (2009) found that oil price shocks affect industrial production in Saudi Arabia and Iran. However, the effects was limited in the case of Indonesia. In another paper, Mahboub and Ahmed (2017) investigated the effects of oil price shocks on industrial sector in Saudi Arabia. The results from the VAR model revealed that oil price shocks do not affect the manufacturing sector in the short run, and it may have an effect on the manufacturing sector after 10 quarters according to the Impulse Response Function.

Ojapinwa and Ejumedia (2012) investigated the empirical effect of oil price shocks on industrial output in Nigeria. The study employed the Vector Autoregressive Model (VAR). The results revealed that oil price, exchange rate, and inflation affect negatively, positively, and negatively industrial output, respectively. Recently, Alao and Payaslioglu (2021) estimated the symmetric and asymmetric effects of oil price on industrial sector in Brazil and Mexico. They found that the dynamic linkages between oil price and industrial production (IP) in Brazil and Mexico persistently co-move and the interdependence between oil price and IP of the world is temporary.

2. Industrial policy in Algeria

2.1 Historical development of industrial policy in Algeria

The industrial sector is one of the sectors that Algerian Government focused on because it is the key sector to diversify the economy, reduce the unemployment, and to develop an export-oriented industrial sector. In this regard, since independence in 1962, the authorities have adopted many industrial strategies. During the socialist period (1970-1989), they have implemented an industrial strategy based on heavy industries called industrializing industries' model. During these two decades, the hydrocarbon revenues and external debts have financed the manufacturing strategy based on large-scale projects in the industrial sector (Souar et al. 2019). This strategy did not appear to be succeeding because the government has sacrificed other sector such as agriculture, consumer goods and housing. Furthermore, the lack of coherence between the priority industries adopted in the Algerian plans and the hierarchy of industrializing industries, the limit size of the domestic market, the inefficient management techniques and business management have constrained this strategy (Teulon and Fernandez, 2014). In fact, the manufacturing output as a part of GDP was fell from 17.21% in 1970 to 11.38% in 1990 (Omolade and Ngalawa, 2016).

In order to correct all these dysfonctionnements after 1990, Algeria began the transition process to market-based economy in the early 1990s, by promulgation of the Ordinance 10-90, dated April 10th, 1990, on Money and Credit, which reformed the banking sector and the monetary policy, and the adoption of the stabilization and Structural Adjustment Programs over 1994-1998. During this period, the reforms braked sharply the industrial sector and aggravated deindustrialization because of many factors: the adverse economic and politic trends, the

privatization and restructuration that closed several public enterprises and resulted in the dissolution of 935 local public enterprises (Herizi and Balkacem, 2016; Herizi, 2012). The manufacturing output as a part of GDP was fell from 11.38% in 1990 to 7.46% in 2000 (Omolade and Ngalawa, 2016). According to Bouri (2020), the underutilization of industrial capacity increased from 30% in 1989 to 60% in 1998, and the decline of industrial production in the same period was about 25.8%.

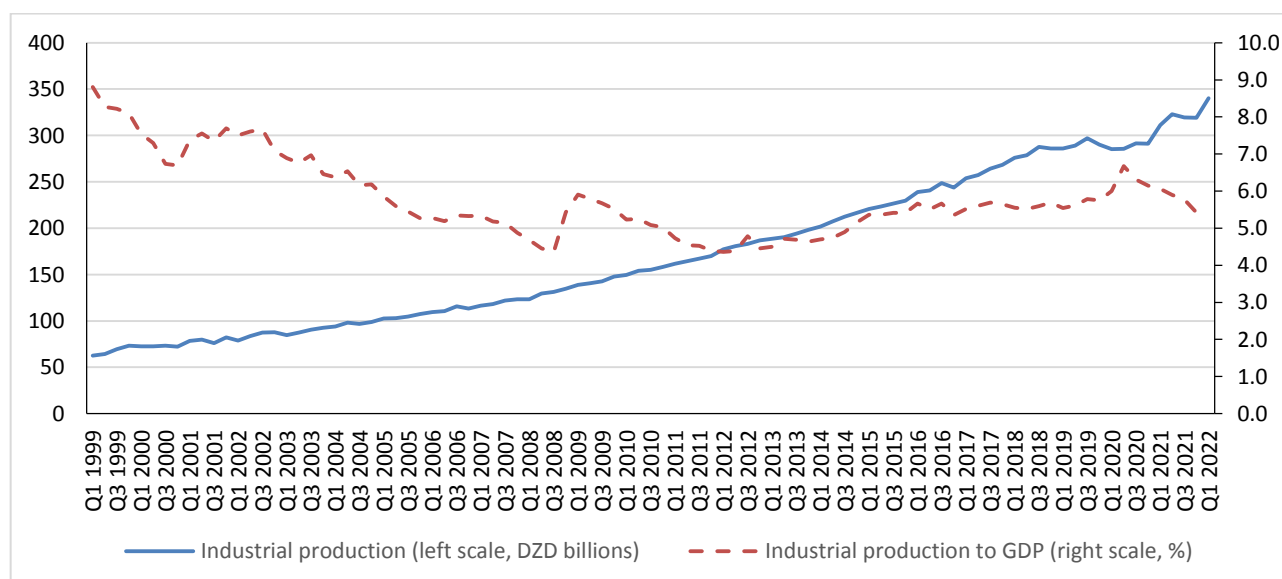
The availability of large hydrocarbon resources in the 2000s led to the implementation of large-scale spending programs. During this period, the Ministry of Participation and Promotion of Investment (MPPI) proposed in 2007 a new industry strategy based on the poles of competitiveness and excellence located by the SNAT 2025 (MPPI, 2007). The objective is to create new industrial areas called "Integrated Industrial Development Zones" or ZIDI, but this strategy has failed to promote industrialization in Algeria. In this regard, the new strategy has based on the valorization of the national industrial potential, upgrading public enterprises, and promotion of foreign direct investment (Ministère de l'Industrie et des Mines, 2015). However, it did not contribute to the macroeconomic stabilization, to the promotion of non-hydrocarbon exports, and to the reduction of unemployment (Zemirli, 2019).

This failure of the Algerian industrial policy can be perceived through the weak performance of the Algerian industrial context observed through several indicators presented in the following point.

2.2 Current State of the Industrial Sector in Algeria

Despite the efforts of governments during the transition to market based economy since 1990s to revitalize the ailing manufacturing sector, the results achieved are modest. However, from the figure 1, the industrial production increased from 62.6 DZD billions in 1999Q1 to 340.2 DZD billions in 2022Q1, but the industrial production to GDP ratio decrease from 8.8% to 5.3% in the same period, respectively, reflecting an insufficient representation of the value added of the industrial sector and a stagnation of industrial products. Furthermore, the oil price shocks affected negatively the industrial production to GDP ratio in 2008 subprime crises, and COVID-19 crisis. This situation showed limited role of industrial sector on reducing the dependence of Algerian economy on hydrocarbon revenues, a weak performance, insufficient of productivity and competitiveness of industries in Algeria.

Fig.1. Industrial production in Algeria between 1999:Q1 and 2022:Q1

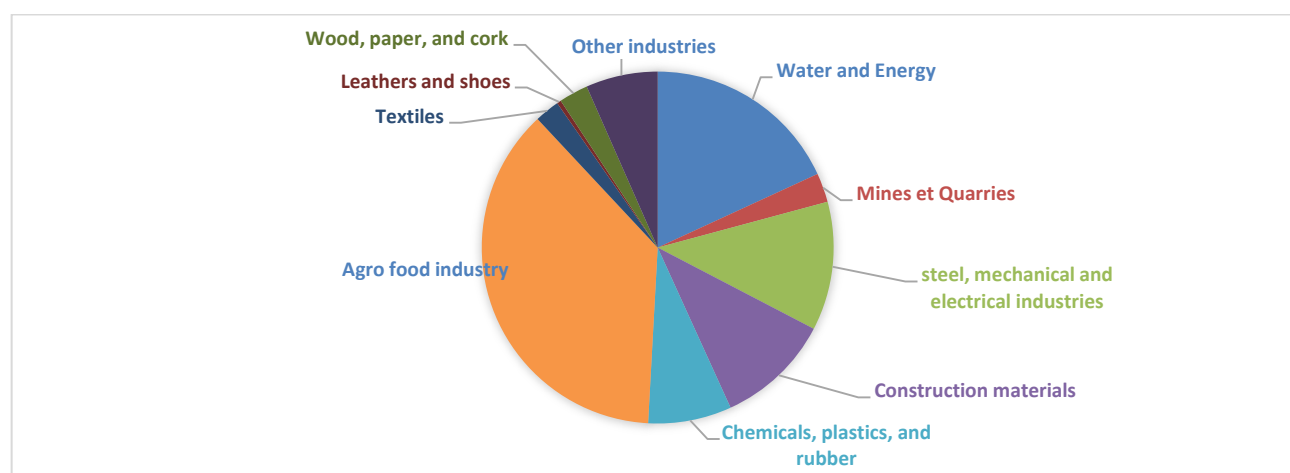


Source: Prepared by authors based on the following sources:

- ONS (2015), les comptes nationaux trimestriels au 3^{ème} trimestre 2015, N°731.
- ONS (2019), les comptes nationaux trimestriels au 1^{er} trimestre 2019, N°859.
- ONS (2022), les comptes nationaux trimestriels au 1^{er} trimestre 2022, N°962.

Regarding the sub-sectors, the agro food industries account about 37.2% of total industry production during 1999:Q1-2022:Q1. This is due to the tendency of the private sector to invest in light food industries characterized by high local demand, easy investment and quick profits. Nevertheless, the food industry imports most of its inputs and has a very low export capacity (Herizi and Balkacem, 2016). The parts of water and energy, and steel, mechanical and electrical industries on total industry production were about 18.1 and 11.8%, respectively. The construction materials account about 10.6% of total industry production, due to infrastructure and housing construction programs. Other industries suffer from stagnation due to insufficient competition. There is no doubt that the opening of the local market without a clear policy for products imported from China, Turkey and other countries has caused local companies to leave the local market.

Fig.2. Part of industries by sub-sectors in total industry production between 1999:Q1 and 2022:Q1

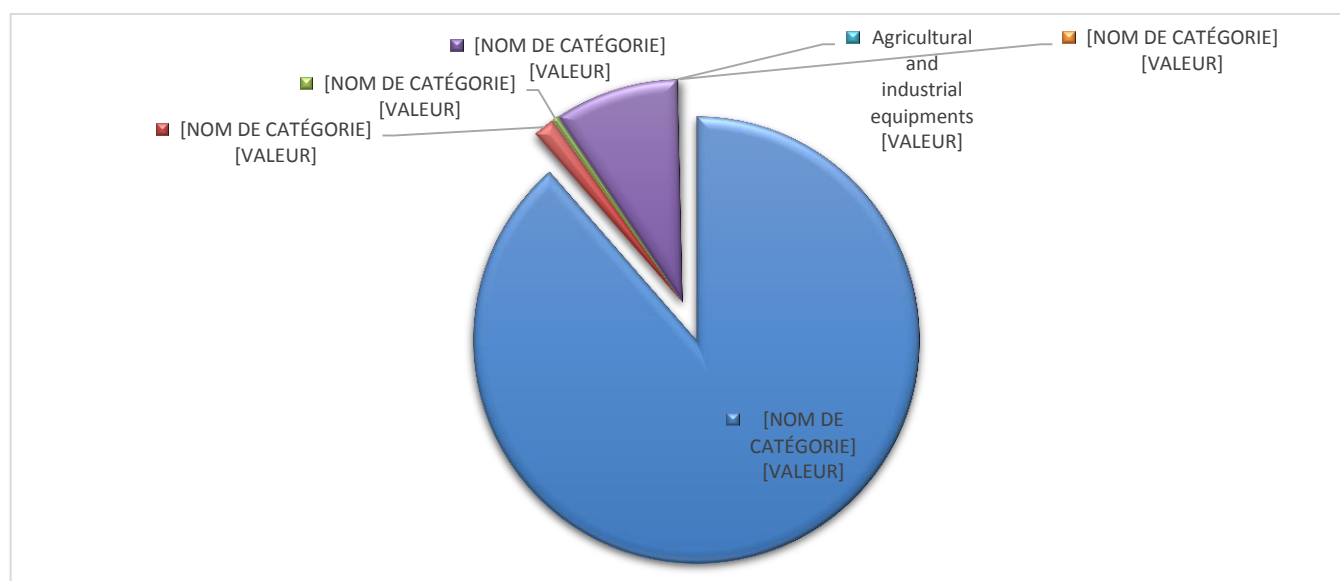


Source: Prepared by authors based on the following sources:

- ONS (2015), les comptes nationaux trimestriels au 3^{ème} trimestre 2015, N°731.
- ONS (2019), les comptes nationaux trimestriels au 1^{er} trimestre 2019, N°859.
- ONS (2022), les comptes nationaux trimestriels au 1^{er} trimestre 2022, N°962.

The following figure shows that the structure of export is dominated by the hydrocarbon sector by more than 88% of total exports in 2021. The semi-finished products account about 9% of total exports. Due to the absence of a clear strategy to develop an export-oriented industrial sector, the part of foods, agricultural and industrial equipment, and consumer goods did not exceed 2% in total exports. The difficulty of accelerating the pace of structural transformation towards industries with higher technological content, and the low level of integration into the Global Value Chains (GVCs) are the principal reasons to the vulnerability of Algerian economy to oil shocks.

Fig.3. Export composition of Algeria in 2021(%)



Source: Prepared by authors based on the following source: Bank of Algeria (2021), Quarterly Statistical Bulletin, No.56, December, p.28.

From the previous indicators, the industrial strategies in Algeria did not contribute to strengthening the industrial base, and failed to realize structural transformation of the economy. An effective industrial policy, which should encourage private investment especially small and medium enterprises, attract and orient foreign direct investment toward complex sector, develop human capital, accelerate economic reforms, improve business climate, rehabilitation of public industrial companies, can contribute to diversify the economy, reduce unemployment, improve the non-hydrocarbon exports, and reduce the import bill.

3. Data and Methodology

3.1 Data

Since industrial output data series is available after 1999, we use quarterly time series data, which covers the period 1999: Q1- 2022: Q1. As shown in Table 1, the data was collected from the *International Financial Statics* of IMF, the *Primary Commodity Prices* of IMF, and the *National Office of Statistics*. More precisely, the dependent variable is the logarithm of real industrial production ($\ln IND_t$). The independent variables include the logarithm of real oil price ($\ln OIL_t$). We also incorporate the macroeconomic fundamentals including the logarithm of discount rate ($\ln R_t$) as monetary policy instrument. In this regard, the decline in interest rate (expansionary monetary policy) leads to a reduction in the real long-term interest rate, which rises the industrial investment, thereby leading to an increase in industrial output. There are other variables that are important determinants of industrial production such as the logarithm of exchange rate ($\ln ER_t$), the inflation rate ($\ln CPI_t$), and the logarithm of bank credit to the economy ($\ln CRED_t$). The depreciation of local currency against foreign currencies increases the competitiveness of domestic industrial products and rise the exports. In the period of study, Algeria has witnessed several cases of depreciation of the dinar against the US dollar, and it is important to estimate its impact on industrial output. The high level of inflation affects negatively the local demand and reduces the industrial output. We have incorporated the bank credit as a determinant of industrial production because the banking sector is the principal component of the financial system in Algeria.

Table 1. Variable definition and sources

Variables	Definition	Sources
$lnIND_t$	Logarithm of real industrial production expressed in Algerian Dinar. Nominal industrial output is deflated by consumer price index (CPI).	National Office of Statistics (https://www.ons.dz/).
$lnOIL_t$	Logarithm of real oil price is obtained by multiplying the nominal oil price expressed in U.S. Dollars by the nominal exchange rate and deflating it by CPI. Nominal oil price is the simple average of three spot prices; Dated Brent, West Texas Intermediate, and the Dubai Fateh.	<i>Primary Commodity Prices</i> of IMF for oil prices, and IFS for exchange rate.
$lnCRED_t$	Logarithm of bank credit to the economy	<i>International Financial Statistics</i> of IMF
lnR_t	Logarithm of Discount rate as monetary policy rate	<i>International Financial Statistics</i> of IMF
$lnER_t$	Logarithm of exchange rate	<i>International Financial Statistics</i> of IMF
$lnCPI_t$	Logarithm of consumer price index (CPI).	<i>International Financial Statistics</i> of IMF

Source: The Authors.

The descriptive statistics of the dependent variable and independent variables are reported in Table 2. The logarithm of real oil price averages 8.397653 but there is wide variation with the highest being 9.105775 and the lowest being 7.084989. The reason is that the period of the study witnessed several years of high oil prices, as well as several oil shocks. On the logarithm of real industrial output, logarithm of bank credit to the economy, logarithm of discount rate, logarithm of consumer price index, and logarithm of exchange rate, again we see wide variations from 4.475881, 6.564366, 1.252763, 4.541902, and 4.107096, respectively, to 5.279481, 9.343355, 2.251292, 5.164843, and 4.959061, respectively, and averaging 4.992571, 8.088959, 1.465917, 4.643472, and 4.451892, respectively. This situation reflects the dependence of the macroeconomic performance in Algeria to oil prices variations (see Appendix 1).

Table 2. Descriptive statistics of the selected variables

Variables	Obs	Mean	Std.Dev.	Min	Max
$lnIND_t$	93	4.992571	0.217972	4.475881	5.279481
$lnOIL_t$	93	8.397653	0.406092	7.084989	9.105775
$lnCRED_t$	93	8.088959	0.879327	6.564366	9.343355
lnR_t	93	1.465917	0.226891	1.252763	2.251292
$lnER_t$	93	4.451892	0.230363	4.107096	4.959061
$lnCPI_t$	93	4.643472	0.280978	4.541902	5.164843

Source: Author's calculation based on the results obtained by Eviews 12.

4.2 Methodology:

We estimate the model by the following equation:

$$\ln IND_t = \gamma_0 + \gamma_1 \ln OIL_t + \gamma_2 \ln CRED_t + \gamma_3 \ln R_t + \gamma_4 \ln ER_t + \gamma_5 \ln CPI_t + \mu_t \quad \dots \dots \dots (1)$$

The equation (1) captured only the long run determinants of excess liquidity. To estimate the short run and long run determinants in one-step, we rewrite the equation (1) as an ARDL model developed by Pesaran et al. (2001) as follows:

$$\begin{aligned} \Delta \ln IND_t = & \alpha_0 + \sum_{i=1}^p \alpha_{1i} \Delta \ln IND_{t-i} + \sum_{i=0}^p \alpha_{2i} \Delta \ln OIL_{t-i} + \sum_{i=0}^p \alpha_{3i} \Delta \ln CRED_{t-i} + \sum_{i=0}^p \alpha_{4i} \Delta \ln R_{t-i} \\ & + \sum_{i=0}^p \alpha_{5i} \Delta \ln ER_{t-i} + \sum_{i=0}^p \alpha_{6i} \Delta \ln CPI_{t-i} + \beta_1 \ln IND_{t-1} + \beta_2 \ln OIL_{t-1} + \beta_3 \ln CRED_{t-1} \\ & + \beta_4 \ln R_{t-1} + \beta_5 \ln ER_{t-1} + \beta_6 \ln CPI_{t-1} + \varepsilon_t \dots \dots \dots (2) \end{aligned}$$

Where: Δ is the first difference of variables, and ε_t is the error term. In the first step, we use the F-test to determine the existence of long-run co-integration relationship among variables in equation (2). The null hypothesis of no co-integration is defined by $H_0: \beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = 0$, is tested against the alternative hypothesis $H_1: \beta_1 \neq \beta_2 \neq \beta_3 \neq \beta_4 \neq \beta_5 \neq \beta_6 \neq 0$. Pesaran et al. (2001) have tabulated two sets of appropriate critical values. This test contains lower and upper critical values. If the calculated F-statistic is higher than the upper bound, the null is rejected, indicating co-integration. If the calculated F-statistic is lower than the lower level of the band, the null cannot be rejected, indicating that there is no co-integration relationship.

Once the co-integration is confirmed, we move to the second step and estimate the long run coefficients. The optimum lag length is identified using Akaike info Criterion (AIC), Schwarz info Criterion (SIC) and Hannan-Quinn info criterion (HQ). The long run elasticities are computed by dividing the coefficients ($\beta_2, \beta_3, \beta_4, \beta_5, \beta_6$) by $(-\beta_1)$ from the ARDL model in equation (2). In the third step, we estimate the short-run coefficients using the following conditional error correction model that employs the ARDL model:

$$\begin{aligned} \Delta \ln IND_t = & \alpha_0 + \sum_{i=1}^p \alpha_{1i} \Delta \ln IND_{t-i} + \sum_{i=0}^p \alpha_{2i} \Delta \ln OIL_{t-i} + \sum_{i=0}^p \alpha_{3i} \Delta \ln CRED_{t-i} + \sum_{i=0}^p \alpha_{4i} \Delta \ln R_{t-i} \\ & + \sum_{i=0}^p \alpha_{5i} \Delta \ln ER_{t-i} + \sum_{i=0}^p \alpha_{6i} \Delta \ln CPI_{t-i} + \theta ECM_{t-1} + \varepsilon_t \dots \dots \dots (3) \end{aligned}$$

Where: Δ is the first difference of variables, the parameters α_{1i} to α_{6i} are the short-run dynamics of the model, ECM_{t-1} is one period lagged error correction term, θ is the error correction coefficient which measures the speed of adjustment to the long-run equilibrium, and ε_t is the error term. A negative and significant error correction coefficient will be an indicator of co-integration amongst variables.

Finally, we apply the diagnostic tests to examine the serial correlation, normality, heteroscedasticity, and Functional form. We test also the stability of our model using the recursive methods proposed by Brown, Durbin et al. (1975), including the cumulative sum of recursive residuals (CUSUM) and cumulative sum of squares of recursive residuals (CUSUMSQ).

From the linear ARDL model in Eq. (2), all exogenous variables have symmetric effects on Industrial output. To investigate the asymmetric effects of one of the determinants on real industrial output, we use the non-linear ARDL approach proposed by Shin et al. (2014). Focusing on the real oil price, the hypothesis is that the impact of oil price increase on real

industrial output is different in size and sign to the impact of oil price decrease. To test this hypothesis, we generate changes in the $\ln OIL$ variable as $\Delta \ln OIL$, and construct from this new series the partial sum of positive and negative values as follows:

$$\ln OIL_t^+ = \sum_{i=1}^t \Delta \ln OIL_{it}^+ = \sum_{i=1}^t \max(\Delta \ln OIL_i, 0) \dots \dots \dots (3)$$

$$\ln OIL_t^- = \sum_{i=1}^t \Delta \ln OIL_{it}^- = \sum_{i=1}^t \min(\Delta \ln OIL_i, 0) \dots \dots \dots (4)$$

Where $\ln OIL_t^+$ and $\ln OIL_t^-$ are the partial sum of positive and negative values of $\Delta \ln OIL$, respectively. We substitute $\ln OIL$ in the ARDL model presented in Eq. (2) by the two new variables $\ln OIL_t^+$ and $\ln OIL_t^-$, to obtain the following non-linear ARDL:

$$\begin{aligned} \Delta \ln IND_t = & \alpha + \sum_{i=1}^{n1} \beta_i \Delta \ln IND_{t-i} + \sum_{i=1}^{n2} \gamma_i \Delta \ln CRED_{t-i} + \sum_{i=1}^{n3} \vartheta_i^+ \Delta \ln OIL_{t-i}^+ + \sum_{i=1}^{n4} \vartheta_i^- \Delta \ln OIL_{t-i}^- + \\ & \sum_{i=1}^{n5} \sigma_i \Delta \ln R_{t-i} + \sum_{i=1}^{n6} \delta_i \Delta \ln ER_{t-i} + \sum_{i=1}^{n7} \phi_i \Delta \ln CPI_{t-i} + \mu_0 \ln IND_{t-1} + \mu_1 \ln CRED_{t-1} + \\ & \mu_2^+ \ln OIL_{t-1}^+ + \mu_2^- \ln OIL_{t-1}^- + \mu_3 \ln R_{t-1} + \mu_4 \ln ER_{t-1} + \mu_5 \ln CPI_{t-1} + \varepsilon_t \dots \dots \dots (5) \end{aligned}$$

According to Shin et al. (2014), the same method and tests of Pesaran et al. (2001) for the ARDL model are applicable for the non-linear ARDL model. Once Eq. (5) is estimated using the OLS method, we test for the existence of any long-term relationship among variables using the same F-test of Pesaran et al. (2001).

The estimation of Eq. (5) provides the long-term and short-term effects of each variable. The next step is to examine the presence of any asymmetric effects of real oil price on real industrial output in the short-term and the long-term by using the Wald test. This test checks the null hypothesis of symmetry against the alternative of asymmetry. For the long-term, the null hypothesis to test is $\frac{\mu_2^+}{-\mu_0} = \frac{\mu_2^-}{-\mu_0}$. For the short-term, the null hypothesis to test takes the forms: $\sum_{i=1}^n \vartheta_i^+ = \sum_{i=1}^n \vartheta_i^-$, or $\vartheta_i^+ = \vartheta_i^-$ for a given lag order $i = 1, 2, \dots, n$. This means that the long-term and short-term asymmetric effects will be established when we reject the null hypothesis. Finally, we derived the dynamic multiplier of one percent change in $\ln OIL_t^+$ and $\ln OIL_t^-$, respectively as:

$$dm_h^+ = \sum_{i=0}^h \frac{\partial \ln IND_{t+i}}{\partial \ln OIL_t^+}, dm_h^- = \sum_{i=0}^h \frac{\partial \ln IND_{t+i}}{\partial \ln OIL_t^-}, h = 0, 1, 2.$$

Note that if $h \rightarrow \infty$, then $dm_h^+ \rightarrow \frac{\mu_2^+}{-\mu_0}$, $dm_h^- \rightarrow \frac{\mu_2^-}{-\mu_0}$.

4. Interpretation of results

As an initial step, we test unit root using the Augmented Dickey–Fuller (ADF) test and Phillips–Perron (PP) test for all variables at level and first difference, in order to insure that the series are not integrated of order two (I(2)) or more. From Table 3, all variables were (I(1)), except the logarithm of industrial output which was (I(0)) for the PP test, and the logarithm of real oil price and the logarithm of discount rate which were (I(0)) for the ADF and PP tests. Therefore, we have a mixture of variables integrated of order zero and one, and an ARDL model is appropriate.

Table 3. ADF and PP unit root tests of all variables

Test models	ADF test		PP test	
	$\ln IND$	$\Delta(\ln IND)$	$\ln IND$	$\Delta(\ln IND)$
Intercept alone	-3.974423*	-8.336738*	-3.849048*	-12.80645*
Trend & intercept	0.588110	-6.926818*	-3.510872**	-17.59708*
	$\ln OIL$	$\Delta(\ln OIL)$	$\ln OIL$	$\Delta(\ln OIL)$

Intercept alone	-3.256232**	-7.929837*	-3.256232**	-9.370672*
Trend & intercept	-3.352193***	-7.853151*	-3.387376***	-9.295496*
	$\ln CRED$	$\Delta(\ln CRED)$	$\ln CRED$	$\Delta(\ln CRED)$
Intercept alone	-1.8528	-3.98442*	-1.191341	-10.07761*
Trend & intercept	-0.739428	-4.37844*	-0.726573	-10.12992*
	$\ln R_t$	$\Delta(\ln R_t)$	$\ln R_t$	$\Delta(\ln R_t)$
Intercept alone	-3.642283*	-6.977415**	-8.57221*	-10.23748*
Trend & intercept	-3.644631**	-7.491069**	-6.444616*	-11.30346*
	$\ln ER_t$	$\Delta(\ln ER)_t$	$\ln ER_t$	$\Delta(\ln ER)_t$
Intercept alone	0.771905	-8.302751*	0.550433	-8.339771*
Trend & intercept	-0.730780	-8.478832*	-0.910717	-8.478829*
	$\ln CPI_t$	$\Delta(\ln CPI)_t$	$\ln CPI_t$	$\Delta(\ln CPI)_t$
Intercept alone	1.736795	-8.662799*	2.183631	-8.688595
Trend & intercept	-2.892511	-9.023895*	-2.841795	-9.221843*

Notes. *, **, and *** significance at 1%, 5% and 10%, respectively. Number of lags for ADF test selected by AIC.

Source: Author's calculation based on the results obtained by Eviews 12.

In the second stage, we estimate both linear and non-linear ARDL presented in Eq. (2) and Eq. (5), respectively. We use the Akaike Information Criterion (AIC) to select the optimum lag. The results are reported in Table 4 for linear ARDL and Table 5 for non-linear ARDL. For each table: Panel A reports short-term effects; Panel B reports long-term effects; and Panel C reports diagnostic statistics.

From the short-term estimates in Table 2 Panel A, it appears that oil price did not affect industrial production in the short-run. The bank credit, exchange rate, and discount rate had a short-term effect on the industrial output, but this effect is not clear because it is positive and negative at different lags. According to the long-term estimates in Panel B, all variables carry their expected signs and significant coefficients except for the discount rate and exchange rate, which were insignificant. The coefficient obtained for real oil price is 0.0601 and significant at 1%. This result suggests that 1% increase in real oil price will rise the real industrial output by 0.0601%. The coefficient estimates obtained for credit to the economy is 0.399, implying that a rise in the bank credit to the economy by 1% will rise the real industrial output by 0.339%. Finally, an increase in the inflation rate by 1% will decrease the real industrial output by 0.545%.

Next, we check the existence of a long-term co-integration relationship among variables using the F-test. From the results reported in Panel C, the null hypothesis of no co-integration is rejected, because the calculated F-statistics (5.7237) exceeds the upper critical bound at one percent. Furthermore, the error correction coefficient is negative and significant at 1% according to t-test, and indicating the existence of co-integration relationship between the real industrial output and the dependent variables. The error correction coefficient is equal to -0.5599, and shows that the industrial output converges to its long-term equilibrium level by 55.99%.

Table 4. ARDL estimation of Eq. (2)

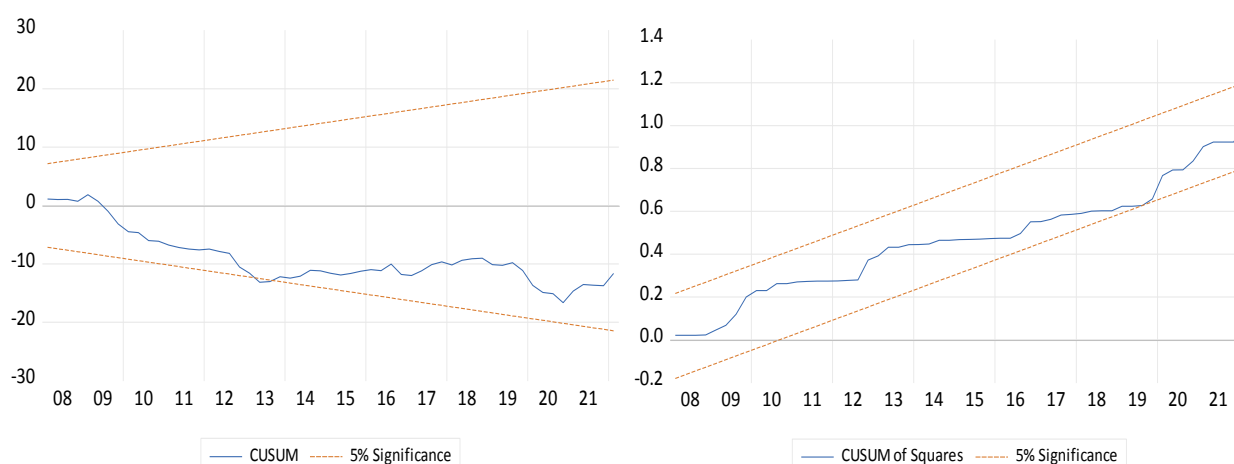
Panel A: Short-term coefficients estimate							
Lag order	0	1	2	3	4	5	
$\Delta \ln IND$							
$\Delta \ln OIL$							
$\Delta \ln R$	0.0227 (0.3993)	-0.08 (-1.5412)	0.016 (0.3481)	0.086 (1.9291)***	-0.096 (-2.005)**	0.1446 (2.9603)*	
$\Delta \ln CRED$	0.1943 (3.639)*	-0.229 (-4.077)*	-0.038 (-0.906)	-0.133 (-3.103)*	-0.133 (-3.103)*	-0.1778 (-4.192)*	
$\Delta \ln ER$	0.061 (1.055)	0.09 (1.597)	0.028 (0.500)	-0.13 (-2.327)**	0.106 (1.918)***		
$\Delta \ln CPI$	-0.497 (-2.967)*	0.278 (1.775)***	-0.14 (-0.913)	0.461 (3.045)*	0.137 (0.894)	0.394 (2.664)**	
Panel B: Long-term coefficients estimate							
Constant	$\ln CRED$	$\ln OIL$	$\ln R$	$\ln ER$	$\ln CPI$		
2.102 (6.144)*	0.3994 (5.3845)*	0.0601 (2.6745)*	0.0857 (1.1545)	-0.0142 (-0.2145)	-0.5457 (-2.2319)**		
Panel C: Diagnostic statistics							
$F - statistics$	ECM_{t-1}	X^2_{SC}	X^2_{NOR}	X^2_{HET}	X^2_{RESET}	$CUS(CUS^2)$	$Adj. R^2$
5.7237*	-0.5599 (-6.111)*	0.3107 (0.7342)	9.8901 (0.007)*	0.2154 (0.8066)	0.1909 (0.8267)	unstable(stable)	0.65

Notes. Number between parenthesis are t-statistics. *, **, and *** significance at 1%, 5% and 10%, respectively. The upper critical value of the F-statistics when there are five exogenous variables is 4.68, 3.79, and 3.35 at the 1%, 5%, and 10% level of significance. This comes from Pesaran et al. (2001), Table CI, Case III, p. 300. The critical value for significance of ECM_{t-1} is -4.79, -4.19, and -3.86 at the 1%, 5%, and 10% level when there are five exogenous variables. This comes from Pesaran et al. (2001, Table CII, Case III, p. 303). X^2_{SC} , X^2_{NOR} , X^2_{HET} , and X^2_{RESET} refer to LM test of serial correlation, Normality, heteroscedasticity, and Functional form. The numbers between parenthesis for these tests are the probabilities. CUS and CUS^2 are cumulative sum of recursive residuals and cumulative sum of squares of recursive residuals, respectively.

Source: Author's calculation based on the results obtained by Eviews 12.

We reported the diagnostic tests in Panel C. The residual is normally distributed according to Jarque-Bera test (X^2_{NOR}). The Lagrange Multiplier statistic reported as (X^2_{SC}) was significant at 1% indicating the presence of serial correlation. The test for heteroscedasticity X^2_{HET} was insignificant showing that our model has no heteroscedasticity problem. In addition, the Ramsey's RESET test for functional form X^2_{RESET} was insignificant. Finally, the results of CUSUM and CUSUMQ tests for stability of all coefficient estimates reported in Panel C and presented in Figure 4 indicate that estimates are unstable for the CUSUM test and stable for the CUSUMQ test.

Fig.4. Plots of CUSUM and CUSUMQ stability tests of the ARDL model



Source: Author's calculation based on the results obtained by Eviews 12.

As discussed above, we found that the results of CUSUM test for stability of all coefficient estimates indicate that estimates were unstable. Furthermore, The Lagrange Multiplier statistic was significant at 1% indicating the presence of serial correlation. Given that many researchers found that the impact of oil price on industrial sector was asymmetric in many cases (see section 2), can the estimation of the nonlinear ARDL model that introducing nonlinear adjustment of real oil price change the outcome^f. To test this hypothesis in the case of Algeria, we estimate the non-linear ARDL model in Eq. (5). The results are reported in Table 5. The estimated results of the short-term relationship presented in Panel A showed that each variable carries at least one significant coefficient, except for the coefficient estimates for $\Delta \ln OIL^-$ which equals zero. Therefore, the sum of the short-term coefficients for $\Delta \ln OIL^-$ equal zero ($\sum_{i=1}^n \vartheta_i^- = 0$), supporting the fact that the decrease in the oil price did not affect the industrial production in the short-term. The coefficient estimates obtained for $\Delta \ln OIL^+$ were positive, implying that a rise in the real oil price increase the industrial production. Consequently, the sum of the short-term coefficients obtained for $\Delta \ln OIL^+$ are different to zero ($\sum_{i=1}^n \vartheta_i^+ \neq 0$). Therefore, the short-term effects seem to be asymmetric by nature. Furthermore, the short-term asymmetry effects are supported by the significant Wald test reported as Wald-S in Panel C.

The long-term results indicate significant asymmetric effects of oil price on industrial output in Panel B. The coefficients obtained for $\ln OIL^+$ and $\ln OIL^-$ were 0.0675 and 0.0613, respectively, and statistically significant at 5%. These results are a clear sign of long-term asymmetry in terms of size and adjustment process, which is supported by the significant Wald test reported as Wald-L in Panel C. The findings obtained suggest that 1% increase (decrease) in real oil price will raise (reduce) the real industrial output by 0.0675% (0.0613%). The positive relationship between increased real oil prices and real industrial output reflects the adoption of expansionary fiscal policies during prolonged higher oil prices period that increase manufacturing production. The prolonged weak oil prices will reduce government revenues and increase the budget deficit significantly. To face this situation, the government adopts austerity-spending policies that reducing the industrial output and growth.

The results suggest that bank credit and inflation have a positive and negative effect on real industrial output, respectively. The findings obtained suggest that 1% increase in bank credit and inflation will raise (reduce) the real industrial output by 0.411% (0.616%). In contrast, the coefficient of discount rate is insignificant. The insignificant of discount rate coefficient reflects the ineffective monetary policy in affecting real sectors in Algeria (Ilmane, 2006 & 2012; Lahreche, 2014). Furthermore, the coefficient of exchange rate is insignificant because Algeria's continued dependence on imports to meet its needs for goods and services, makes successive devaluations of the Dinar ineffective in increasing the competitiveness of industrial sector and other tradable sectors. This ineffectiveness is due to the absence of a clear strategy to develop an export-oriented industrial sector (Boubellouta and Shahbaz (2019)).

Panel C presents the diagnostic test of the non-linear model. We can see that there is evidence of co-integration when the non-linear form is adopted, since the F-statistic exceeds the upper critical bound at five percent. Furthermore, the error correction coefficient is negative and significant at 1% according to t-test, and indicating the existence of co-integration relationship between the industrial output and the dependent variables and supports nonlinear adjustment and the NARDL model. The error correction coefficient is equal to -0.5263, and shows that the industrial output converges to its long-term equilibrium level by 52.63%. The Jarque-Bera test indicates that the residual follows normal distribution. The LM test indicates no evidence of serial correlation. The ARCH test shows that the residuals have constant variance over time. The Ramsey's RESET test indicates that the model is correctly specified. The

adjusted R^2 is about 0.67 and shows a high power of independent variables in explaining dependent variables compared to linear specification in Table 4.

Table 5. Nonlinear ARDL estimation of Eq. (5)

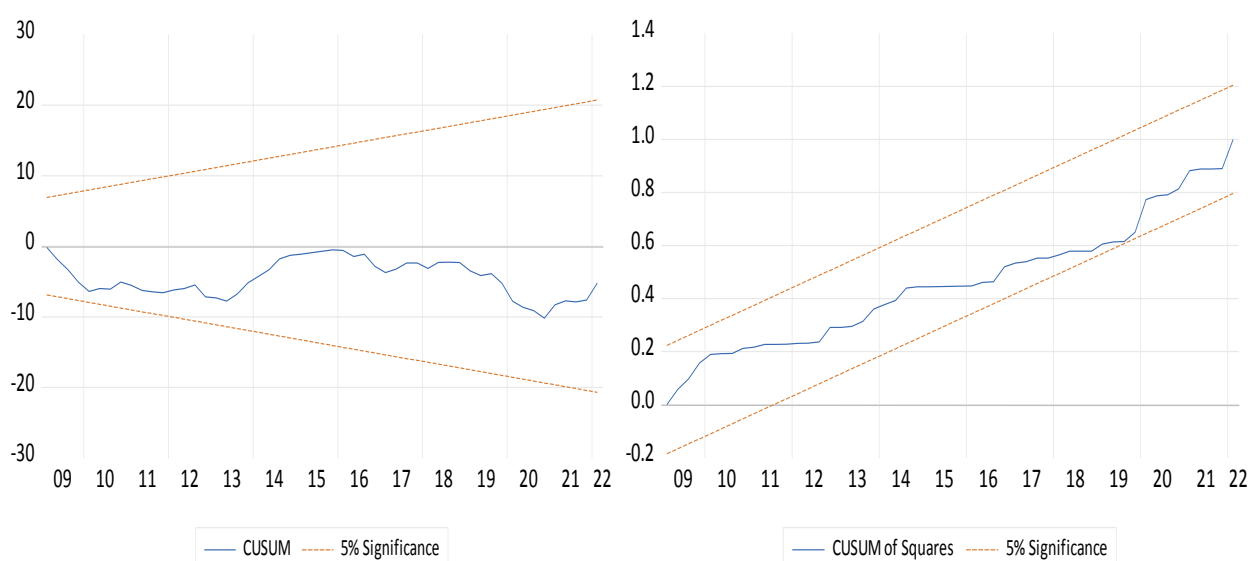
Panel A: Short-term coefficients estimate									
Lag order	0	1	2	3	4	5			
$\Delta \ln IND$									
$\Delta \ln OIL^+$	0.0346 (1.694)***	0.0378 (1.755)***							
$\Delta \ln OIL^-$									
$\Delta \ln CRED$	0.2001 (3.7901)*	-0.218 (-3.876)*	-0.036 (-0.799)	0.0216 (0.459)	-0.129 (-3.062)*	-0.172 (-4.078)*			
$\Delta \ln R$	0.021 (0.358)	-0.096 (-1.883)***	-0.005 (-0.117)	0.077 (1.718)***	-0.113 (-2.384)**	0.152 (2.943)*			
$\Delta \ln ER$	0.079 (1.361)	0.092 (1.624)	0.003 (0.067)	-0.15 (-2.681)*	0.103 (1.822)***				
$\Delta \ln CPI$	-0.503 (-3.051)*	0.327 (2.028)**	-0.168 (-1.078)	0.467 (3.119)*	0.136 (0.894)	0.414 (2.728)*			
Panel B: Long-term coefficients estimate									
Constant	$\ln OIL^+$	$\ln OIL^-$	$\ln CRED$	$\ln R$	$\ln ER$	$\ln CPI$			
2.3514 (7.7737)*	0.0675 (2.056)**	0.0613 (2.475)**	0.411 (5.119)*	0.101 (1.246)	-0.007 (-0.097)	-0.616 (-1.887)***			
Panel C: Diagnostic statistics									
F-statistics	ECM_{t-1}	Wald-L	Wald-S	X_{SC}^2	X_{NOR}^2	X_{HET}^2	X_{RESET}^2	$CUS(CUS^2)$	Adj. R ²
3.6408**	-0.5263 (-5.321)*	2.883 (0.095)***	1.9482 (0.056)***	0.2185 (0.804)	4.4751 (0.106)	0.0296 (0.970)	0.2313 (0.794)	stable(stable)	0.67

Notes. The numbers between parenthesis are t-statistics. *, **, and *** significance at 1%, 5% and 10%, respectively. The upper critical value of the F-statistics when there are six exogenous variables is 4.43, 3.61, and 3.23 at the 1%, 5%, and 10% level of significance. This comes from Pesaran et al. (2001), Table CI, Case III, p. 300. The critical value for significance of ECM_{t-1} is -4.99, -4.38 and -4.04 at the 1%, 5%, and 10% level when there are six exogenous variables. This comes from Pesaran et al. (2001, Table CII, Case III, p. 303). X_{SC}^2 , X_{NOR}^2 , X_{HET}^2 , and X_{RESET}^2 refer to LM test of serial correlation, normality, heteroscedasticity, and functional form. The numbers between parenthesis for these tests are the probabilities. CUS and CUS^2 are cumulative sum of recursive residuals and cumulative sum of squares of recursive residuals, respectively.

Source: Author's calculation based on the results obtained by Eviews 12.

The results of CUSUM and CUSUMQ tests presented in Figure 5 indicate that the estimates are stable because the plots of these two tests stay within the 5% significance level.

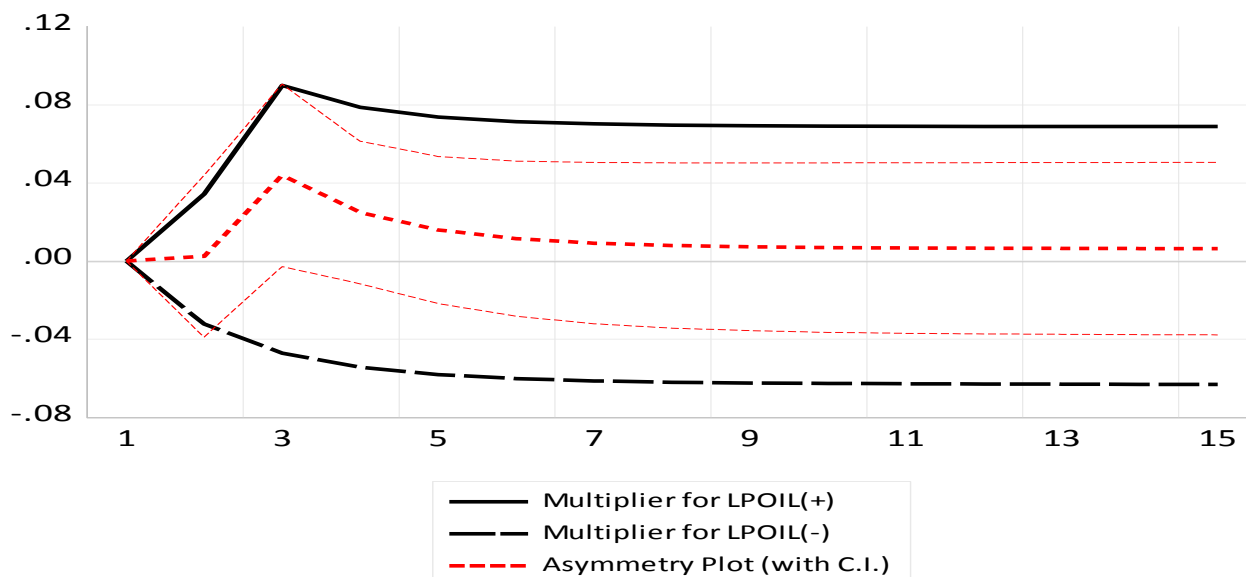
Fig.5. Plots of CUSUM and CUSUMQ stability tests of the nonlinear ARDL model



Source: Author's calculation based on the results obtained by Eviews 12.

We compute the dynamic multiplier of real oil price increase and decrease on real industrial output as shown in Figure 6. The increased (decreased) real oil price takes 3 (15) quarters to be fully transferred to the industrial production and converges to the long-term coefficients 0.0675 (0.0613).

Fig.6. Dynamic Multiplier effects of real oil price increase and decrease



Source: Author's calculation based on the results obtained by Eviews 12.

Conclusion

The literature emphasized that the oil price shocks affect industrial production in oil importing and exporting countries. Despite this, to the best of authors knowledge, no study in Algeria as an oil-producing economy has estimated the determinants of industrial production after including oil price. Hence, understanding the empirical effects of oil price increase and decrease on industrial output is very important for government in the formulation of effective industrial policies in prolonged higher and weaker oil price periods, and adopting appropriate policies to accommodate these shocks to achieve economic stability.

In this paper, we wanted to know whether the impact of real oil price on industrial output over 1999:Q1–2022:Q1 is symmetric or asymmetric. In this context, we have examined the linear ARDL model. Then, we have employed the non-linear ARDL model to capture both long-term and short-term asymmetric relationships between industrial output and real oil price. The results from the ARDL model reveal that the model seems to have been misspecified, since The Lagrange Multiplier statistic was significant at 1%, and indicating the presence of serial correlation. Furthermore, by employing the CUSUM test, it is revealed that the estimates are unstable. However, we have shown that fully stable estimates can be obtained from the non-linear ARDL model. In addition, the non-linear ARDL model confirmed that the real oil price has a short-term and long-term effect on the industrial output. Furthermore, both the short-term and long-term effects were asymmetric. More precisely, in the short-term, only an oil price increase seems to rise industrial output. In the long-term, an oil price increase raised the industrial output, while an oil price decrease reduced the industrial output. The dynamic multiplier has provided additional evidence that industrial output responded more to an oil price increase compared to an oil price decrease. Furthermore, the bank credit and inflation affected positively and negatively industrial output, respectively. In contrast, the discount rate and exchange rate did not affect industrial output in the long run.

The previous results means that the prolonged higher oil prices period accompanied by the adoption of expansionary fiscal policies increase the manufacturing production in Algeria. In contrast, the adoption of austerity-spending policies during prolonged weak oil prices period reduce the industrial output. Furthermore, the bank credit and inflation have a positive and negative effect on real industrial output, respectively. However, the coefficients of discount rate and exchange rate are insignificant, and reflect the ineffective monetary policy in affecting real sectors and the absence of a clear strategy to develop an export-oriented industrial sector.

The results may be useful for policy-makers in Algeria. First, authorities should take into consideration that the short-term and long-term asymmetric responses of industrial output to real oil price is an important channel in which oil shocks can be transmitted to the macroeconomy in Algeria.

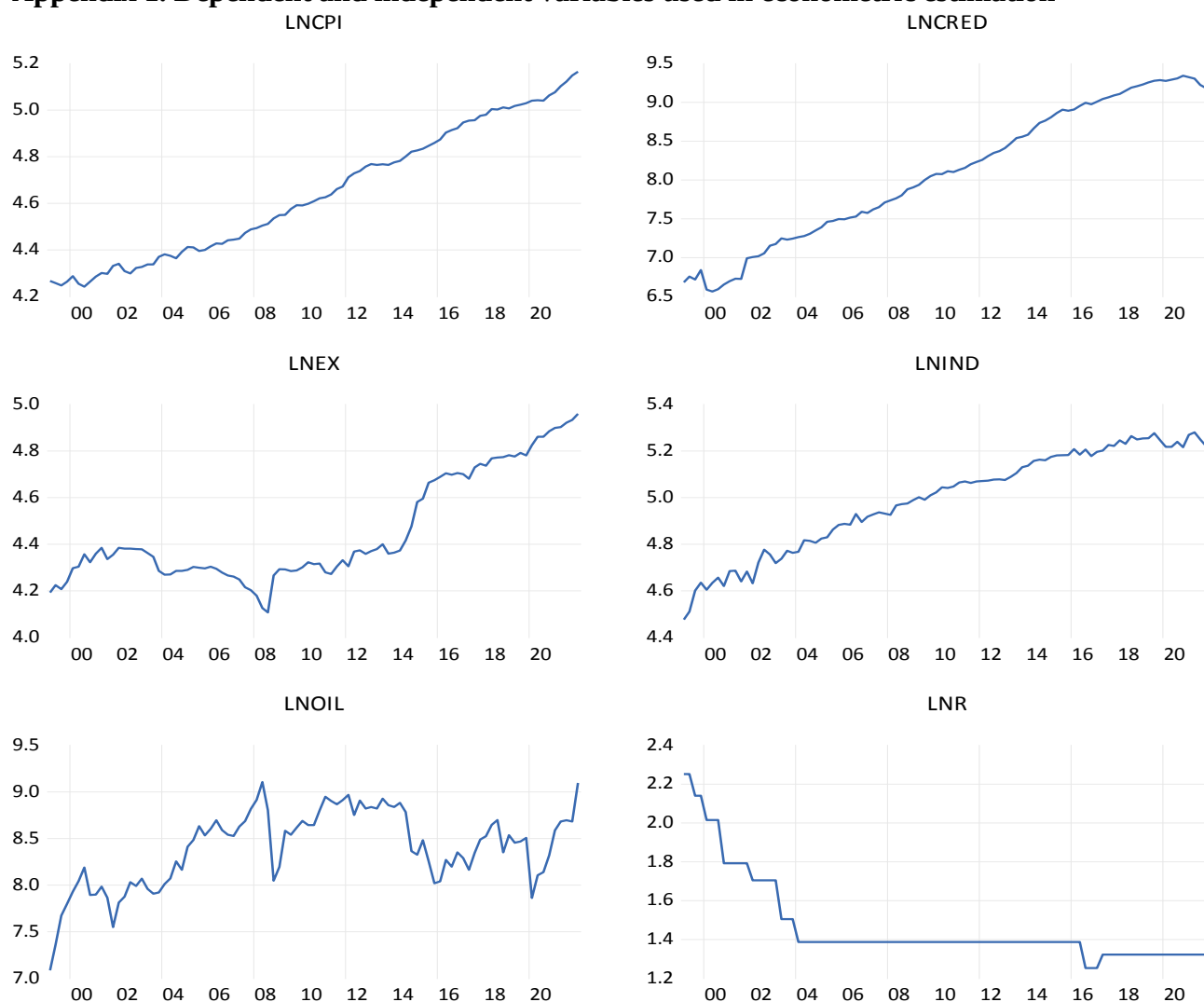
Second, the long-term responses of industrial output to increased and decreased oil price are asymmetric. The reason for this is due to the asymmetric responses of fiscal policies to oil prices shocks. Third, given that the effect of inflation on industrial output was negative, it is important to enhance the effectiveness of monetary policy in Algeria to maintain stable prices. Furthermore, the insignificant of exchange rate coefficient means that the devaluation of the Dinar affect the expectations of economic agents and increases economic instability due to high inflation rates, which increases the negative impact of low oil prices on the Algerian economy. As a result, authorities should diversify the national economy and develop an export-oriented sector.

Bibliography List:

1. Alao, R. O., and Payaslioglu, C. (2021), Oil price uncertainty and industrial production in oil-exporting countries, *Resources Policy*, Volume 70.
2. Alper, C.E., and Torul, O. (2009), Asymmetric effects of oil prices on the manufacturing sector in Turkey. Paper presented at the 29th Annual Conference of MEEA in San Francisco, January 2009, United States of America.
3. Aye, G. C., Dadam, V., Gupta, R. and Mamba, B. (2014), Oil Price Uncertainty and Manufacturing Production, *Energy Economics*, Volume 43, 41–47.
4. Bank of Algeria (2021), Quarterly Statistical Bulletin, No.56, December.
5. Bjornland, H. C. (2008), Oil Price Shocks and Stock Market Booms in an Oil Exporting Country, *Scottish Journal of Political Economy*, Vol.56, No.2, pp.232–254.
6. Boubellouta, B. and Shahbaz, M. (2019), Comparing the relationship between nominal and real effective exchange rates during the last two devaluations in Algeria, *Global Business Review*. <https://doi.org/10.1177/0972150919844402>.
7. Bouri, N. (2020), The manufacturing sector in Algeria: analysis and interpretation of annual variations, *Revue du Lareiid*, No.7, December, pp.1-17.
8. Brown, R.L., Durbin, J., and Evans, J.M., (1975), Techniques for testing the constancy of regression relations over time, *Journal of the Royal Statistical Society*, Vol.37, pp.149-192.
9. Brown, S.P.A. and Yücel, M.K. (2002), Energy prices and aggregate economic activity: an interpretative survey', *Quarterly Review of Economics and Finance*, Vol. 42, No. 2, pp.193–208.
10. Cologni, A. and Manera, M. (2008), Oil price, inflation and interest rates in a structural cointegrated VAR model for the G-7 countries, *Energy economics*, Vol. 30, No. 3, pp.856–888.
11. Herizi, R. (2012), La privatisation des entreprises industrielles en Algérie, doctoral Thesis, University of Lyon 2, France, p 445.
12. Herizi, R., and Belkacem, D. (2016), Local industrial development in Algeria, *Journal of Business and Retail Management Research (JBRMR)* Vol. 10, No.3, pp.24-33.
13. Ilmane, M.C., (2006), Réflexions sur la politique monétaire en Algérie : objectifs, instruments et résultats (2000-2004). *Cahiers du CREAD*, Vol.75, pp.69-107.
14. Ilmane, M.C., (2012), The three phases of banking and monetary system development in Algeria. Paper presented at the International Seminar - Algeria: Fifty years of development experience State-Economy-Society, December. Algiers: Research Center in Applied Economics for Development.
15. Jimenez-Rodriguez, R. and Sanchez, M. (2012), Oil Price Shocks and Japanese Macroeconomic Developments, *Asian-Pacific Economic Literature*, Vol.26, No.1, pp.69–83.
16. Kliesen, K. L. (2006), Rising Natural Gas Prices and Real Economic Activity, *Federal Reserve Bank of St. Louis Review*, Vol.88, No.6, pp.511-526.
17. Kumar, S. (2009), The Macroeconomic Effects of Oil Price Shocks: Empirical Evidence for India, *Economics Bulletin*, Vol.29, No.1, pp.15–37.
18. Lahreche, A. (2014), Enhancing the effectiveness of monetary policy in Algeria, *IMF Country Report*, No.14/34, February, pp.3-25.
19. Lee, K. and Ni, S. (2002), On the dynamic effects of oil price shocks: a study using industrial level data, *Journal of Monetary Economics*, Vol.49, pp.823-852.
20. Mahboub, A.A., and Ahmed, H.E. (2017), The effects of oil price shocks on the Saudi manufacturing sector, *Economics World*, My-June, Vol.5, No.3, pp.230-238.

21. Mehrara, M. and Sarem, M. (2009), Effects of oil price shocks on industrial production: evidence from some oil-exporting countries, *Journal of OPEC Energy Review*, Vol.33, pp.170–183.
22. Ministère de l'industrie et des mines (2015), *Politique gouvernementale dans le domaine de l'industrie et des mines*, Septembre.
23. MPPI (2007), Ministry of Participations and Investment Promotion: Preliminary draft white paper: "Strategy and industrial development policy".
24. Ojapinwa T. V. and Ejumedia, P. E. (2012), The Industrial Impact of Oil Price Shocks In Nigeria: (1970 – 2010), *European Scientific Journal*, Vol.8, No.12, pp.1857–7881.
25. Omoladen A., and Ngalawan H. (2016), Monetary policy transmission and growth of the manufacturing sector in Algeria. *Investment Management and Financial Innovations*, Vol.13, No.4-1, pp.212-224.
26. ONS (2015), les comptes nationaux trimestriels au 3^{ème} trimestre 2015, No.731.
27. ONS (2019), les comptes nationaux trimestriels au 1^{er} trimestre 2019, No.859.
28. ONS (2022), les comptes nationaux trimestriels au 1^{er} trimestre 2022, No.962.
29. Pesaran, M.H., Shin, Y. and Smith, R.J. (2001), Bounds Testing Approaches to the Analysis of Level Relationships, *Journal of Applied Econometrics*, Vol. 16, No. 3, pp.289–326.
30. Shin, Y., Yu, B. and Greenwood-Nimmo, M. (2014), Modelling Asymmetric Cointegration and Dynamic Multipliers in a Nonlinear ARDL Framework, In W. C. Horrace, and R. C. Sickles (Eds.), *Festschrift in Honor of Peter Schmidt: Econometric Methods and Applications*. New York: Springer Sciences and Business Media.
31. Souar, Y., Abdelhakim, A., and Azzazen, H. (2019), Historical survey of the industrialization policies in Algeria – an analytical study for the period (1970-2016), *Beam Journal of Economic Studies*, Vol.3, No.1, pp.376-394.
32. Teulon, F., and Fernandez, D. B. (2014), Industrialization and economic policy in Algeria: a synthesis over half Century, *Workin Paper no.2014-287*, IPAG Business School, France.
33. Wang, X. and Zhang. (2014), The impacts of global oil price shocks on China's fundamental industries, *Energy Policy*, Vol.68, pp.394–402.
34. Zemirli, R. (2019), Analyse de l'effet de la politique industrielle sur le décollage du secteur industriel algérien, *Afaq Journal of resaurch and Studies*, Vol.2, No.1, pp.235-249.

Appendix 1. Dependent and independent variables used in econometric estimation



Source: The Authors based on Eviews 12.