

ASYMMETRIC EFFECTS OF OIL REVENUES ON PUBLIC SPENDING IN ALGERIA: A NARDL APPROACH.

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Abstract:

The motivation for this study is to evaluate the effectiveness of the tax reforms undertaken in recent decades by the Algerian authorities to diversify the tax base and reduce the share of budgeted oil revenues. To this end, we performed an econometric estimation, using a non-linear autoregressive distributed lag (NARDL) approach, of the asymmetric relationship between real public expenditures, real oil revenues, and real non-oil revenues. Using annual data from 1970 to 2022, our research highlights the existence of a non-linear relationship between Algerian real public expenditures and our main variables. Our results show that a positive shock to real oil revenues has a positive and significant impact on real public expenditures, while a negative shock has a positive but not significant impact. Based on our estimation results, we formulate several recommendations for public policy.

Keywords: Asymmetric; oil revenues; public spending; NARDL model; Algeria.

JEL Classification Codes: Q33, H50, C22

1- Introduction:

On the surface, oil appears to be an invaluable source of wealth, capable of accelerating the growth of nations that possess it, giving them

a distinct advantage over those that lack it. Yet, since the end of the 20th century, a growing body of empirical research has challenged this idea. Several analysts even observe that the considerable revenues derived from oil, or the sharp increases in its global price, often turn into a veritable curse for producing countries. This phenomenon stems from a development model overly dependent on the exploitation and massive export of hydrocarbons (Matsuyama , 1992 ; Corden & Neary, 1982). The first theoretical explanation for this paradox is the "Dutch disease," a concept formulated in the 1960s following the discovery of significant gas and oil deposits in the Netherlands. Arzelier (1998) defines the concept as a theory centered on evaluating the effects of the massive export of natural resources such as hydrocarbons on the growth of the different sectors composing the economy. A second analysis, of a behavioral nature, complements this perspective. It posits that the abundance of natural resources, and the belief in their sustainability, can weaken the will to diversify the economy, innovate, and undertake ventures, due to the narcotic effect of oil rents (Gacem, 2007) . In the specific case of Algeria, numerous studies have examined the validity of the Dutch disease hypothesis, and the majority of results confirm its existence (Benyoub & Benyoub, 2018; Mezaour & Belaid, 2020) .

In recent years, oil-exporting countries have experienced significant shifts in their public finances due to fluctuations in oil prices. Indeed, the average annual price of crude oil rose from \$23 per barrel in 2001 to \$107 in 2011 and remained relatively stable around \$100 until 2014. It then experienced a drastic drop of over 50% in 2015 due to intense global geopolitical and economic turmoil. The price of oil subsequently settled at an average annual rate of around \$50 until 2020 before beginning a dramatic rebound in the context of the war in Ukraine, reaching \$102 per barrel in 2022 (Moussa et al., 2022). Algeria, a rentier economy, has experienced significant fluctuations in its oil revenues throughout these periods of substantial price volatility. The Algerian authorities have therefore undertaken a series of tax reforms in order to reduce the economy's dependence on hydrocarbons, to mitigate the effects of continuous variations in tax revenues due to oil revenues and to diversify other sectors of the economy.

These reforms followed the fundamental reform of 1992. The latter focused primarily on simplifying the tax system through the introduction

of three new taxes: value-added tax, corporate income tax, and global income tax. This was followed by an ongoing process of reform, the main measures of which included modernizing and restructuring the tax administration, supporting productive investment, simplifying and broadening the tax base for various taxes, strengthening taxpayer protections, harmonizing administrative procedures for national and international businesses, combating the informal market and reducing its size, implementing a voluntary tax compliance program, harmonizing with international standards, improving collection procedures , and strengthening tax audits, etc. (Mahtout, 2019) .

Thus, in this study, we attempt to examine the effectiveness of the aforementioned tax reforms through the following central question: have the tax reforms enabled a diversification of the tax base, in particular an increase in non-hydrocarbon tax revenues and a decrease in dependence on oil revenues ?

Therefore, our research hypothesis is as follows: oil revenues significantly influence and drive public spending in a rentier economy such as Algeria. We justify our hypothesis based on the work of Abdel-Latif & al. (2018) .

To provide answers to our research question and to confirm or refute our hypothesis, the objective of this work is to examine the effectiveness of the aforementioned reforms through an econometric study using the NARDL model of the asymmetric relationship between real oil revenues and real Algerian public expenditures for the period 1970-2022. This work is structured in three sections. The first is dedicated to a literature review on public expenditures and the various variables under study. The second section will present the data and the methodology used. The third section will present the results.

2- Literature review

The influence of tax revenues generated by oil revenues on public spending in oil-producing countries has always been an open question in empirical research. Some earlier work on the tax expenditure hypothesis has notably supported the idea of a unidirectional causal relationship from public revenues to public spending. Thus, according to this hypothesis, an increase in government revenues would lead to an

increase in public spending (Buchanan & Wagner, 1978; Friedman, 1978) . Dizaji (2014) confirmed the tax expenditure hypothesis for the case of Iran. Indeed, the author studied the dynamic relationship between public revenues and public spending in Iran, a developing economy based on oil exports. The results of these models show a strong causal relationship from public revenues to public spending in the Iranian economy. Using a nonlinear ARDL model, Abdel-Latif et al. (2018) examined the effect of oil shocks on public spending in the health and education sectors in Saudi Arabia. Their research concluded that there is a nonlinear relationship between oil prices and public spending, where a negative oil price shock has a negative effect. Positive shocks, on the other hand, have a positive and statistically significant effect compared to negative shocks. Using the ARDL model for the period 1996–2017, Moussa et al. (2022) analyzed the dynamic relationship between changes in oil revenues due to variations in the international oil price and public spending in CEMAC countries. Their econometric results show a positive and significant effect of changes in oil revenues on public spending in the short term, but in the long term, the effect is positive but not significant. The author also added the variable of tax pressure rate, which allows for the capture of non-oil revenues. These results show that the tax pressure rate has a negative impact on public spending.

Some empirical studies on the influence of oil revenues on public spending have incorporated institutional quality. Matallah (2020) tested the impact of oil rents on economic growth and examined the role of governance in combating the resource curse and transforming oil rents into a tool for economic diversification in MENA countries during the period 1996–2014, using OLS and GMM methods. The results of their study show that the growth of MENA countries is significantly and positively influenced by oil rents. Furthermore, the author concludes that oil-exporting countries in the MENA region are diagnosed as suffering from a resource curse and emphasizes that the heavy dependence of these economies on oil rents generates a poor governance framework. According to the author, strengthening the good governance capacities of oil-exporting countries in the MENA region is the way to escape the resource curse. In studying the correlation between institutional quality and natural resource revenues in several rentier states, Wantchekon (2002) highlights a lack of transparency in budget management

associated with poor institutional quality. He argues that natural resource wealth facilitates the consolidation of an already established authoritarian government. To maintain power, this government manipulates the composition of public spending by leveraging natural resource rents. His findings suggest that the rentier nature of African and Asian economies is a crucial determinant of their political regimes. The author proposes major reforms to the revenue allocation process to support democratization efforts in rentier states such as Nigeria, Indonesia, and Kazakhstan. Similarly, Mehlum et al. (2006) emphasize in their research the vital role of institutions in resource-rich countries. According to the authors, good institutions are those that favor producers by redirecting rents into productive sectors, thus allowing the country to benefit positively from natural resources, develop its economy, and create wealth. Conversely, poor institutions are those that allow the gains from natural resources to benefit hoarders, particularly political leaders, thus giving rise to the curse of wealth.

To determine whether massive public spending accelerated the pace of economic growth in the Kingdom of Bahrain, Hamdi and Sbia (2013) examined the dynamic relationship between oil revenues, public spending, and economic growth. Using Johansen's (1988) multivariate cointegration, the results of the cointegration tests suggest the existence of a single cointegrating vector with a significance level of 1%. The long-term results show that the coefficients of the variables total public spending and oil revenues are positive and statistically significant. They further demonstrate unidirectional Granger causality from oil revenues to GDP. The authors posit that oil revenues constitute the primary driver of development and progress in the small kingdom and that a positive or negative shock rapidly impacts economic growth. Other authors have examined the role of exchange rates in rentier economies. For example, Alssadek & Benhin (2021) analyze the Dutch disease in a global sample of 36 oil-rich developed and developing countries for the period 1970–2016. Their analysis focuses on both expenditure and resource flows. The results show that an oil boom leads to exchange rate appreciation and a decline in productivity in the agricultural, manufacturing, and service sectors across all oil-rich countries. According to the authors, exchange rate appreciation and declining sectoral output are two key characteristics of the Dutch disease, resulting respectively from the

effects of expenditure and resource flows, leading to weak economic growth and development. Di Giorgio et al. (2018) This study examines the exchange rate response to a government spending shock in a two-country model with productive government purchases and non-Ricardian households. They also find a depreciation of the exchange rate following an increase in domestic government spending. This depreciation occurs both during the impact and the transition. According to the authors, this response is due to government purchases stimulating domestic private sector productivity and reducing real marginal costs in the country, thus allowing for an accommodative monetary policy response. Bouakez & Eyquem (2015) arrive at the same result in a study of the effect of a change in government spending on the real exchange rate. The authors conclude that there is a large depreciation of the real exchange rate after an expansionary government spending shock. Their results are consistent with several empirical studies on the issue, but with a smaller real depreciation compared to the others.

3- Data and methodology

3-1. Data

Our study covers the period from 1970 to 2022, and all our variables are in real values to eliminate the effect of inflation. Our main variables are real government spending, real oil and non-oil revenues as a percentage of real GDP, and our control variables, chosen based on the literature, are the real GDP growth rate, the population growth rate, and the official exchange rate against the US dollar. We explain the choice of variables and the sources of the data collected in the following sections.

- Real public expenditure as a percentage of real GDP is our dependent variable. It constitutes the expenditures made by the State, local authorities, and their affiliated administrations and agencies for the implementation of government social policy, particularly in the education, training, health, and infrastructure sectors. Public expenditures thus encompass operating and investment expenditures and are primarily financed by tax revenues (Joumard et al., 2003) . We use them in our case to capture the effects of various fluctuations in oil and non-oil

revenues. Data on public expenditures are collected from the website of the Algerian National Statistics Office (ONS).

- Real oil revenues are the total income derived from the sale of crude oil and gas on international markets. We chose them as an explanatory variable to analyze their positive and negative externalities on public spending. The data were collected from the ONS website. Oil revenues fell from over 100% of real GDP in 1975 to 23% in 2000. They continued a significant downward trend until 2022, primarily due to global economic crises and various negative fluctuations in international hydrocarbon prices.
- Real non-oil revenues comprise all income from ordinary taxation and all non-hydrocarbon revenues. Their asymmetrical effects on public spending provide information on the effectiveness of the various reforms undertaken by the Algerian authorities. The data is collected from the ONS website.
- The real GDP growth rate is collected from the World Bank website. It is the annual percentage growth rate of GDP based on constant 2010 US dollars. The choice of this variable in our study is motivated by the work of Aladejare (2022) and Hamdi & Sbia (2013) , who assessed the relationship between public spending and economic growth in the context of a resource-dependent economy.
- The choice of population growth rate reflects previous empirical studies on the relationship between public spending and population (e.g., Brasington, 2024; Krieger & Meierrieks, 2019; Ladd, 1994) . The data are collected from the World Bank website.
- Several previous studies have assessed the link between public spending and the exchange rate, as this variable is influenced by international fluctuations in oil prices (Algozhina , 2022; Bouakez & Eyquem, 2015; Di Giorgio et al., 2018) . Furthermore, it maintains a close relationship with public spending. Exchange rate data were collected from the World Bank website.

3-2. Methodology

To assess the asymmetric effect of oil and non-oil revenues on public spending, we follow a three-step methodology: the first step involves analyzing the descriptive statistics of the time series and determining their integration orders using the Dickey-Fuller unit root test. This test clarifies the choice of model and helps avoid biased regression. The Dickey-Fuller unit root test highlights whether a time series is stationary or non-stationary by determining a deterministic or stochastic trend. The construction of these tests is based on three models, and when the null hypothesis ($H_0: \varphi = 1$) is accepted in one of the three models, the process is considered non-stationary. The test is performed using the Augmented Dickey-Fuller (ADF) test because it accounts for the presence of autocorrelation in the time series.

The second step involves estimating the relationship between our explanatory variables and public spending. To do this, we use the asymmetric version of the autoregressive step lag (ARDL) model (H. Pesaran et al., 2001; MH Pesaran et al., 1999), a model that performs well for small sample sizes. This asymmetric version is the nonlinear ARDL model, developed by Shin et al. (2014), which captures the asymmetric impacts of positive and negative changes. Its functional form is as follows:

$$y_t = \beta^+ x_t^+ + \beta^- x_t^- + \varepsilon_t$$

With y_t : the variable to be explained, x_t^+ and x_t^- are the partial sum process of the positive and negative changes of the dependent variable, and ε_t is the error term. β^+ and β^- denote the long-term asymmetric parameters.

To test for cointegration in the model, Shin et al. (2014) employ the cointegration test at the bounds of Pesaran et al. (2001). This test compares Fisher's F-values to the critical values of the lower and upper bounds simulated by Pesaran. The lower bounds concern the zero-order integrated variables, and the upper bounds concern the first-order integrated variables. Thus, if the calculated F-value is greater than the upper bound, the hypothesis of a cointegration relationship is accepted. If the calculated F-value is less than the lower bound, the non-existence of a cointegration relationship between the variables is accepted.

Conversely, when the calculated F-value is within the bounds, no conclusion can be drawn. To test for skewness, the null hypothesis of no long-term or short-term skewness is tested using the Wald test.

Once the hypothesis of a long-term relationship is accepted, we can proceed with the estimation of the NARDL model. The advantage of this econometric model is that it allows us to capture the short-term and long-term asymmetries of our various explanatory variables on public spending. The model is as follows:

$$RPS = f(ROR, RNOR, RGDPR, PGR, OER)$$

We transform it into a NARDL model as follows:

$$\begin{aligned} RPS_T = & \alpha_0 + \sum_{i=1}^p \alpha_{1i} \Delta RPS_{t-1} + \sum_{i=1}^p \alpha_{2i}^+ \Delta ROR_{t-1}^+ + \sum_{i=1}^p \alpha_{3i}^- \Delta ROR_{t-1}^- \\ & + \sum_{i=1}^p \alpha_{4i}^+ \Delta RNOR_{t-1}^+ + \sum_{i=1}^p \alpha_{5i}^- \Delta RNOR_{t-1}^- + \sum_{i=1}^p \alpha_{6i} RGDPR_{t-1} \\ & + \sum_{i=1}^p \alpha_{7i} \Delta PGR_{t-1} + \sum_{i=1}^p \alpha_{8i} \Delta OER_{t-1} + \beta_1 RPS_t + \beta_2^+ ROR_t^+ \\ & + \beta_3^- ROR_t^- + \beta_4^+ RNOR_t^+ + \beta_5^- RNOR_t^- + \beta_6 RGDPR_t + \beta_7 PGR_t \\ & + \beta_8 OER_t + \varepsilon_t \end{aligned}$$

With

$RPS_t, ROR_t, RNOR_t, RGDPR_t, PGR_t, OER_t$ Respectively, real public spending, real oil revenues, real non-oil revenues, real GDP growth rate, population growth rate and official exchange rate;

$$\begin{aligned} ROR_t^+ &= \sum_{i=1}^t \Delta ROR_t^+ = \sum_{i=1}^t \max(ROR_i, 0) \\ ROR_t^- &= \sum_{i=1}^t \Delta ROR_t^- = \sum_{i=1}^t \min(ROR_i, 0) \\ RNOR_t^+ &= \sum_{i=1}^t \Delta RNOR_t^+ = \sum_{i=1}^t \max(RNOR_i, 0) \\ RNOR_t^- &= \sum_{i=1}^t \Delta RNOR_t^- = \sum_{i=1}^t \min(RNOR_i, 0) \end{aligned}$$

α_0 : the constant;

$\alpha_{1i} \dots \alpha_{7i}$: short-term effects;

$\beta_1 \dots \beta_7$: the long-term effects;

ε_t : estimation residuals;

Δ : the shift operator.

Finally, the last step is dedicated to model validation testing. This includes Jarque -Bera normality tests, Breusch- Pagan heteroscedasticity tests, Breusch- Godfrey autocorrelation tests for estimation errors, and Ramsey stability tests. These various diagnostics allow us to validate our model overall.

4- Results and discussion

4-1. Preliminary analysis

Table N°1: Descriptive statistics of the series

Variables	RPS	ROR	RNOR	RGDPGR	PGR	OER
Mean	117.1419	62.61946	65.42270	3.468622	2.294921	48.41569
Median	52.92815	22.91591	14.12115	3,600,000	2.056248	54.74893
Maximum	314.1916	265.1490	184.5104	27.42397	4.554385	141.9950
Minimum	14.02507	2.914303	6.669169	-11.33172	1.329615	3.837450
Std. Dev.	107.9167	74.98452	69.04958	4.795078	0.731758	42.92815
Jarque - Bera	7.421721	18.58012	7.942195	314.4016	6.106867	3.973443
Probability	0.024456	0.000092	0.018853	0.000000	0.047197	0.137144
Observations	53	53	53	53	53	53

Source: Created by us using results from Eviews 13 software

The descriptive statistics table above provides general information on the mean, maximum value, minimum value, and standard deviation of our data series. We observe that the standard deviations of actual public expenditure, actual oil revenue, and actual non-oil revenue, which are 107.91, 74.98, and 69.04 respectively, are significantly higher compared to other data series because the means are quite far from the median. This result reflects the presence of central tendency in these three variables. As mentioned above, oil revenue is dependent on oil prices, which were highly volatile during our study period. As for public expenditure and non-oil revenue, they increased sharply in the first decades after independence to support the growth of the Algerian economy and its population. The maximum and minimum values can be useful for identifying potential data entry errors and also for assessing the data dispersion. Jarque -Bera statistic indicates a non-normal distribution for all our variables (probability greater than 5%) except for the official exchange rate. This non-normality does not affect our

estimation results within the framework of a NARDL specification; rather, the stationarity and order of integration of our series are important. The correlation matrix of our variables is shown in the following table.

Table N°2: Correlation Matrix

Correlation	RPS	ROR	RNOR	GDPRPR	PGR	OER
RPS	1.000000					
ROR	0.867774	1.000000				
RNOR	0.968994	0.800220	1.000000			
RGDPGR	0.172277	0.223712	0.206723	1.000000		
PGR	0.902312	0.767687	0.855977	0.108554	1.000000	
OER	-0.824732	-0.672908	-0.828553	-0.169242	-0.741868	1.000000

Source: Created by us using results from Eviews 13 software

The data in the table above show a positive correlation between real public spending and all our explanatory variables except for the official exchange rate. This positive correlation is strong for real oil and non-oil revenues, at 0.86 and 0.96 respectively, with a slight advantage for non-oil revenues. In addition to the downward trend in oil prices in recent decades due to political, economic, and health crises that have generated less oil revenue, these results can also be explained by the Algerian authorities' ongoing efforts, through several tax reforms, to promote non-oil revenues and reduce budgeted oil taxes. The population growth rate, meanwhile, has increased steadily during our study period, necessitating an increase in public spending to meet the newly created needs. The weak correlation between the real GDP growth rate and real public spending stems primarily from the less proportional growth of the percentage of real public spending in GDP compared to previous years. The negative correlation between the official exchange rate and real public spending is consistent with the studies by Bouakez & Eyquem (2015) and Di Giorgio et al. (2018) which conclude that there is a sharp depreciation of the real exchange rate after an expansionary shock to public spending.

Table N°3: Unit root tests

Variables	ADF in level at the 5% threshold		ADF in 1st difference at the 5% threshold		Intégration order
	T_{ADF} /exogenous	Prob.	T_{ADF}	Prob.	
RPS	-1,22	0,20	-6,34	0,0006	I (1)
ROR	-2,19/ trend&intercept	0,02	-	-	I (0)
RNOR	-1,29	0,17	-2,43	0,01	I (1)
RGDPGR	-9,57/ trend&intercept	0,000	-	-	I (0)
PGR	-0,77	0,37	-5,12	0,000	I (1)
ER	2,42	0,99	-4,92	0,001	I (1)

Variables	PP in level at the 5% threshold		PP in 1st difference at the 5% threshold		Intégration order
	T_{PP} /exogenous	Prob.	T_{PP}	Prob.	
RPS	-0,91	0,31	-6,46	0,000	I (1)
ROR	-3,20	0,09	-6,09	0,000	I (1)
RNOR	-1,39	0,14	-5,29	0,000	I (1)
RGDPGR	-9,30/ trend&intercept	0,000	-	-	I (0)
PGR	-0,67	0,42	-4,94	0,000	I (1)
ER	-1,55	0,79	-4,92	0,001	I (1)

Source: Created by us using results from Eviews 13 software

The table above shows the results of the Augmented Dickey-Fuller and Phillips-Perron unit root tests. The choice of these two-unit root tests provides reliable results given the importance of stationarity and the integration of variables in a NARDL specification. We observe that all our variables are non-stationary in level at the 5% significance level, with the exception of the real GDP growth rate for both tests. The latter is stationary in level and therefore integrated of order zero in the presence of trend and constant. All other variables are stationary in first difference, and are therefore integrated of order 1. Thus, we opt for the NARDL model, which is better suited to small sample sizes and to a series composed of integrated variables of order zero and/or integrated of order one (Moussa et al., 2022), which is the case for our variables. This model also allows us to capture the asymmetric short- and long-term effects of different explanatory variables on public spending. In the following sections, we perform a cointegration test and estimate the long- and short-term models.

4-2. NARDL Model Estimation

Table N°4 :Cointegration Test

F- statistic = 29.513	Terminals	
Thresholds	Lower	Superior
10%	2,069	3,148
5%	2,414	3,608
1%	3,194	4,562

Source: Created by us using results from Eviews 13 software

Table N°5 :Wald Test

Wald's Test	p-value	Decisions
$W_{LR}(RP)$	0.0015	Asymmetric
$W_{SR}(RP)$	0.0038	Asymmetric
$W_{LR}(RNP)$	0.0006	Asymmetric
$W_{SR}(RNP)$	0.0058	Asymmetric

Source: Created by us using results from Eviews 13 software

Table 4 shows that Fisher's F-statistic (29.51) is greater than the upper bounds at the 10%, 5%, and 1% thresholds. This indicates a cointegration relationship between the selected variables. The long-term estimate of this relationship is given in Table 6.

Furthermore, Table 5 provides information on the Wald statistic for the long- and short-run symmetry tests for oil and non-oil revenues. W_{LR} denotes the Wald statistic for long-run symmetry, which tests the null hypothesis $\beta_k^+ = \beta_k^-$ for the chosen explanatory variables. W_{SR} denotes the Wald statistic for short-term symmetry, which tests the null hypothesis that $\sum_{i=1}^p a_{k,i}^+ = \sum_{i=1}^p a_{k,i}^-$. The null hypothesis of lack of symmetry is rejected at the 5% level (p-value < 5%).

Table N°6 :Long-term relationship

Variable *	Coefficient	Standard Error	t- Statistics	Prob.
ROR POS (-1)	0.778315	0.054328	14.32623	0.0000
ROR NEG	0.013866	0.059668	0.232383	0.8173
RNOR POS	-0.329560	0.222794	-1.479214	0.1464
RNOR NEG	1.313813	0.056088	23.42412	0.0000
RGDPGR (-1)	-1.281586	0.769330	-1.665845	0.1030
PGR (-1)	13.76499	4.897441	2.810649	0.0074
OER	-0.321426	0.053942	-5.958746	0.0000

C	131.0619	19.84632	6.603840	0.0000
Note: * Coefficients derived from the CEC regression.				

Source: Created by us using results from Eviews 13 software

Statistically, the results above show that an increase in oil revenues has a positive and statistically significant effect on public spending at the 1% level, while a decrease in oil revenues has a positive but not significant effect. This confirms our initial hypothesis that oil revenues are the driving force behind public spending in a rentier economy like Algeria. These results demonstrate the Algerian economy's dependence on oil revenues, thus confirming the Dutch disease theory (Abdel-Latif et al., 2018; Matallah, 2020) . Recent decades have been marked by significant fluctuations in international oil prices due to intense geopolitical and economic crises worldwide, coupled with reductions in hydrocarbon export volumes. Algerian authorities have therefore reduced the share of oil revenues relative to tax revenues in order to lessen the dependence of state revenues on the constant fluctuations of oil taxation. Thus, from 2012 to the present, only 50% on average of oil revenue has been budgeted, with the remainder going to the revenue stabilization fund (source: Court of Auditors). The positive but not statistically significant impact of the decline in oil revenue on public spending therefore indicates the outcome of the strategy adopted by the Algerian authorities. They reduced budgeted oil revenue without significantly impacting expenditures. Nevertheless, expenditures remain positively influenced by oil revenues. Economically, a 1% increase in real oil revenues at time $t-1$ leads to a 0.77% increase in real public spending at time t , and a 1% decrease in real oil revenues at time t results in a 0.01% increase in real public spending at time t .

We further note that an expansion of real non-oil revenues has a negative and statistically insignificant effect on public spending, whereas a decrease in real non-oil revenues has a positive and statistically significant effect at the 1% level. This result highlights the ineffectiveness of the reforms undertaken by the Algerian authorities for the diversification of the tax base, as they fail to allow real non-oil revenues to positively and significantly impact real public spending. This therefore poses a problem for financing public spending given the continuous instability of international oil prices and, consequently, of budgeted oil revenues. Non-oil revenues consist of proceeds from direct

taxes, registration and stamp duties, business taxes, indirect taxes, and customs duties. A negative shock to real non-oil revenues has a positive and significant effect on real public spending. This demonstrates that a decrease in non-oil revenues leads to a more than proportional decrease in real public spending. This result can be explained by the substantial contribution of tax revenues, which are a major component of non-oil revenues, and by the coverage of negative shocks by the revenue stabilization fund. Economically, a 1% increase in non-oil revenues leads to a 0.32% decrease in public spending, and a 1% decrease in non-oil revenues leads to a 1.33% decrease in public spending.

Regarding the control variables, we observe a statistically negative relationship between real public spending and the growth rates of real GDP and the official exchange rate. This negative relationship is statistically insignificant for the GDP growth rate but statistically significant for the exchange rate. The negative correlation with the real GDP growth rate can potentially be explained by the unproductive nature of public spending. Indeed, operating expenses, which cover salaries, wage increases, and subsidies, constitute the majority of public expenditure in Algeria. Conversely, investment spending represents a negligible share of the budget, thus holding back the productive sector, which should significantly boost economic growth. Furthermore, the negative and statistically significant relationship between the official exchange rate and real public spending is consistent with the findings of Bouakez & Eyquem (2015) and Di Giorgio et al. (2018) , who demonstrate that a depreciation of the exchange rate follows an increase in public spending and vice versa. According to these authors, this negative response is due to public procurement, which stimulates the productivity of the domestic private sector and reduces real marginal costs in the country, thus enabling an accommodative monetary policy response. Economically, a 1% increase in the real GDP growth rate and a 1% increase in the official exchange rate lead to a decrease of 1.28% and 0.32%, respectively, in real public spending. Regarding the population growth rate, a positive and statistically significant relationship is observed at the 1% level. This result corroborates those found by Muhammad et al. (2023) . Population growth also increases the need for public services, which in turn increases public spending to meet the needs of a larger population. Economically, a 1% population increase

at time $t-1$ leads to a more than proportional increase in public spending of 13.76% at time t . The constant is positive and statistically significant at the 1% level. It represents the y-intercept of the long-term equilibrium relationship.

Table N°7 : Short-term relationship

Variable	Coefficient	Standard Error	t- Statistics	Prob.
COINTEQ*	-0.930190	0.056335	-17.93171	0.0000
D(ROR POS)	0.531838	0.050868	10.45518	0.0000
GDPR	-0.282814	0.227625	-1.242457	0.2204
D (RGDPGR (-1))	1.117723	0.224950	4.968756	0.0000
D(PGR)	5.857564	3.669209	1.596411	0.1172
R- squared	0.896355	Mean dependent variable		-
Adjusted R-squared	0.887343	SD dependent var		2.924124
SE of regression	7.506553	Akaike info criterion		22.36461
Sum squared resid	2592.024	Schwarz criterion		6.962324
likelihood	-172.5393	Hannan-Quinn criter .		7.151719
F- statistic	99.45616	Durbin-Watson stat		7.034697
Prob(F- statistic)	0.000000			1.930321

Source: Created by us using results from Eviews 13 software

The table above presents the results of the error correction model. We observe that the strength of the correction factor towards equilibrium is negative and statistically significant at the 1% level, which allows us to validate the existence of an error correction model. The strength of the correction factor, or the adjustment coefficient (-0.93), indicates a rather strong convergence towards the long-term equilibrium. This result means that short-term deviations from the long-term equilibrium in the variation of tax revenues are corrected 93% of the time annually through feedback. It is this result, in particular, that explains why none of our main variables impacts real public spending in the short term, with the exception of a positive shock to oil revenues. The coefficient associated with the increase in real oil revenues in the short term is positive and statistically significant in the short term at the 1% level. Thus, a 1% increase in real oil revenues at time t leads to a 0.53% increase in real public spending. We observe that, both in the immediate term (i.e., in less than a year) and in the long term, real oil revenues positively impact real public spending. Only two control variables have a short-term

impact: the real GDP growth rate and the population growth rate. We find that the GDP growth rate at time $t-1$ and the population growth rate at time t are positive and statistically significant at the 1% level. Conversely, the real GDP growth rate at time t_a has a negative but statistically insignificant impact.

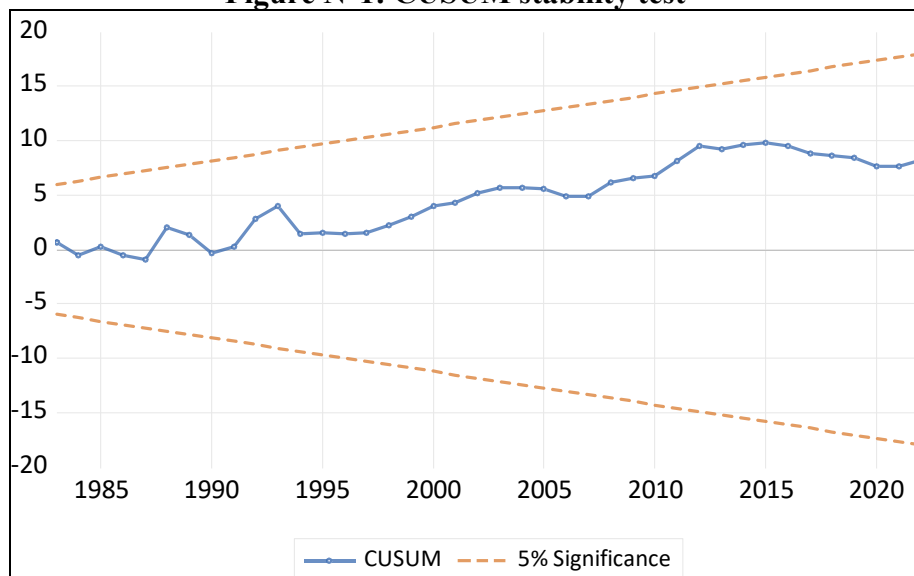
Table N°8 : Model validation test

Test	Null hypotheses (H_0)	$T_{statistic}$	Probabilities
Breusch - Godfrey	No autocorrelation	2.11	0.1355
ARCH	Homoscedastic	1.45	0.23
Ramsey	Well specified	0.96	0.3394
Jarque -Bera	Normally distributed	1.98	0.3699

Source: Created by us using results from Eviews 13 software

We have probabilities greater than 0.05, a result that leads us to accept the null hypothesis. The residuals are then homoscedastic, normally distributed, and not autocorrelated . According to the Ramsey test, the model is well-specified.

Figure N°1: CUSUM stability test



Source: Created by us using results from Eviews 13 software

The CUSUM test is performed on the variables of the estimated model and demonstrates the model's stability. As we can see on the graph, the curve lies between the two critical value lines at the 5% significance level. We can therefore conclude that the parameters are stable, thus representing the true relationship between public spending and tax revenue. The selected model successfully passes the various tests, allowing us to validate it.

5- Conclusion

This study aimed to investigate the asymmetric effect of real oil revenues on real public expenditure in Algeria from 1970 to 2022. To this end, we used the NARDL model, which is appropriate for this scenario and whose choice is confirmed by the Wald test. It is also a well-performing model for small sample sizes. After conducting the cointegration test, a long-term relationship was found between real public expenditure and our various independent variables. Following the estimation of the NARDL model, the long-term model estimation results show that all our variables are statistically significant at the 5% level (probabilities less than 0.05), with the exception of negative oil revenues, positive non-oil revenues, and the real GDP growth rate. A positive (negative) shock to oil revenues has a positive (positive) impact on public expenditure. In light of these results, we confirm our initial hypothesis that oil revenues are a driver of public spending in a rentier economy such as Algeria. The positive impact of real oil revenues is consistent with the findings of Abdel -Latif, Osman, et al. (2018) . These results notably demonstrate the Algerian economy's dependence on oil revenues, thus confirming the Dutch disease theory. Regarding non-oil revenues, we observe that a positive (negative) shock to these revenues has a negative (positive) impact on public spending.. We note that in our work, we did not consider the revenue stabilization fund, which is entirely financed by oil tax revenues. This is an important variable because it allows for the financing of the budget deficit. Indeed, public spending amounted to 6.902 billion dinars in 2020, compared to public revenue of 5.114 billion dinars (source: ONS). Over the past few decades, public spending has consistently exceeded public revenue due to the substantial increase in operating expenses. Our recommendations include, among other things, controlling the spread of tax fraud, reducing the informal economy, strengthening tax services, improving collection

efficiency, diversifying activities in other productive sectors, and effectively improving public spending, particularly operating expenses, in order to minimize the budget deficit. This deficit remains financed by the revenue regulation fund, which itself is dependent on oil tax revenues. These revenues expose the state's finances to vulnerabilities that are beyond its control.

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